SCIENTIFIC AMERICAN SUPPLEMENT No. 452

Scientific American Supplement, Vol. XVIII., No. 452.
Scientific American, established 1845.

NEW YORK, AUGUST 30, 1884.

Scientific American Supplement, $5 a year.
Scientific American and Supplement, $7 a year.

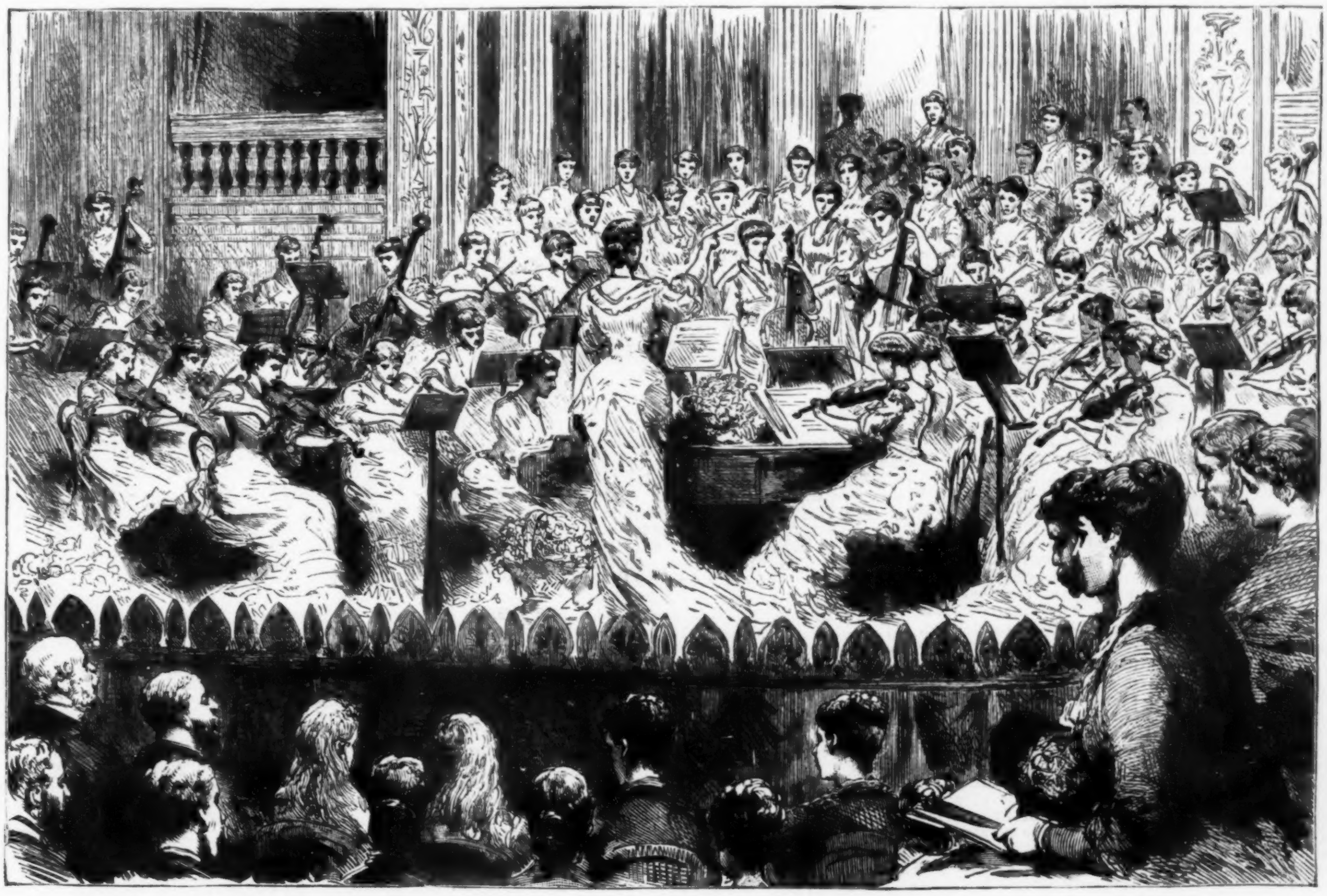
LADIES' ORCHESTRAS.

AMONG occupations suitable for women the playing of instruments in orchestral companies seems to offer unusual advantages. The demand for good music is perpetual, and skillful players are always required. In this country the large summer hotels pay from ten thousand to thirty thousand dollars per season for an orchestra; and in most cases the music might readily be furnished by women.

The same in respect to theaters and concerts. Good orchestras with women as the players doubtless could always find remunerative employment. The most recent effort in this direction is that of a titled lady in England. We copy the accompanying engraving and remarks from the *London Graphic*.

Although an orchestra of ladies is not altogether a novelty, and a lady conductor appeared as long ago as the time of Samuel Pepys, the circumstances under which the Viscountess Folkestone gave two concerts at Prince's Hall last week were sufficently new to warrant a brief description. Lady Folkestone organized her string orchestra and choir in 1882, when she gave a concert at Stafford House in aid of the Royal College of Music. The band, like the choir, formed exclusively from the gentler sex, numbers many ladies of the nobility, and it comprises fourteen first and thirteen second violins, eight violas, eight violoncellos, and even three lady players of that cumbrous instrument, the double bass. These ladies, under the *bâton* of Lady Folkestone, played the march from Handel's "Occasional" overture, the "Lullaby" from Mr. F. H. Cowen's string suite, "In the Olden Time," and the so-called "Concerto Grosso," which is, however, an arrangement by Geminiani of the tenth of the twelve violin sonatas written by Corelli at Rome in 1700. The choir sang a chorus from Dr. Ferdinand Hiller's "Song of Victory," Mendelssohn's "Now May Again," and Mr. Henry Leslie's part song, "The Swallow."

It was a very pretty sight to see Lady Folkestone's executants, the instrumentalists dressed in white, with shoulder-knots of pink or blue, occupying the platform; while the choristers, also dressed in white, with breast-knots of pink, white, or dark red roses, were arranged in tiers of seats at the background. The display of diamonds almost equaled that at a Court concert. The first of Lady Folkestone's concerts was attended by the Prince and Princess of Wales and two of their daughters, and the Princess Louise, and at the conclusion of the performance the royal party shook hands with and warmly congratulated the fair conductor."



OCCUPATION FOR WOMEN.—LADIES' ORCHESTRA, PRINCE'S HALL, LONDON.

THE hay-fever season has begun, and the White Mountain region echoes with the sneezes of the victims of that malady. An annual meeting of the Hay Fever Association will be held soon in Bethlehem.

VIRCHOW ON DARWINISM.

THE attitude of Professor Rudolph Virchow, the eminent pathologist, toward Darwinism has been frequently misrepresented; and he has been held up and oft quoted as violently hostile to the theories of the dead scientist. It is therefore a matter of interest to hear what the great man himself has to say on the subject, the following being his speech delivered at a students' reception during the recent Tercentenary of the Edinburgh University.

"I never was hostile to Darwin, and never have said that Darwinism was a scientific impossibility. But at that time, when I pronounced my opinion on Darwinism at the Association of German Naturalists, at Munich, I was convinced, and still am, that the development which it had taken in Germany was extreme and arbitrary. Allow me to state to you the reasons on which I founded my opinion. First, Darwinism was interpreted in Germany as including the question of the first origin in life, not merely its manner of propagation. Whoever investigates the subject of development comes upon the question of creation of life. This was not a new question. It is the old generatio equivoca, or epigenesis. Does life arise from a peculiar arrangement of inorganic atoms under certain conditions? We can imagine oxygen, carbon, and nitrogen coming together to form albumen, and that out of the albumen there was produced a living cell. All this is possible; but the highest possibility is only a speculation, and cannot be admitted as the basis of a doctrine. In science it is not hypotheses that decide, but facts; we arrive at truth only by investigation and experiment. I need not say that this demand of science for proof, instead of speculation, was long ago made in England. Ever since the time of Bacon it has had a home among you. We may concede that generatio equivoca is a logical possibility. But it is important for you students always to bear in mind the great distinctions between the construction of logical possibilities and their application in practical life. If you try to shape your conduct simply according to logical possibilities, you will often find yourself coming into violent conflict with the stern facts of existence. Let me give you an illustration. In recent times the fact of the presence of minute organisms giving rise to important processes has been recognized, not only in medicine, but in connection with agriculture and various industries. It was of the utmost importance to determine whether these organisms were originated *de novo* in the decomposing bodies, or were produced by similar pre-existing organisms, and introduced from without. A century ago it was possible to admit the spontaneous generation of micro-organisms. But here sits M. Pasteur, the man who has demonstrated, by means of direct experiment, that, in spite of all logical possibility, all known micro-organisms found in decaying matter are derived from similar ancestors. No man would now be justified in practical life in acting on the possibility of a generatio equivoca of micro-organisms. A physician who finds himself in presence of infectious disease among his patients, or an agriculturist whose crops are blighted, or a man engaged in the production of alcohol or sugar by fermentation must set himself to discover what brings about the changes with which he has to deal; he must see that organisms are there which have been imported from without, and must then inquire from whence they have been derived. The physician who has to combat an epidemic dare not act as if the germ were spontaneously produced in any patient. Such is the difference between logical possibilities and the practical work of daily life. Every teacher of science must lead his students to suppose that each living being that he meets must have had a father and mother, or, at least, one or other of them; and every scientific conclusion maintains that one generation is legimately descended from another precisely similar. That was one consideration that led me to warn my fellow countrymen against developing a system out of logical possibilities.

At the very time when we were getting free from the chains of former dogma, we seemed to be in danger of forging new ones for ourselves. The second question concerning Darwinism had regard to the descent of man, whether from apes or other vertebrate animals. Was there anywhere a pro-anthropos? In regard to this question, I thought that the existence of such a precursor of a man was a logical possibility, perhaps a probability. Only I found, to begin with, that it was a purely speculative question; not one raised by any observed phenomenon. No pro-anthropos had ever been discovered; not even a fragment of him. I had myself long been specially occupied in making prehistoric investigation to get near the primitive man. When I began these studies, twenty years ago, there was a general disposition to arrive at this discovery. Everybody who found a skull in a cave, or a bone in the fissure of a rock, thought he had got a bit of him. I wish you specially to notice that the smaller the fragment or skull, the easier it was to make it out to be the skull of the pro-anthropos. It was never thought of where an entire skull was in hand. When the upper part of the cranium alone—the calvarium without the face and the base, as is the case of the Neanderthal skull—was discovered, it was easy, by changing its horizontal position, by elevating either the anterior or posterior part, to give the impression that it had belonged either to a being of a superior or of an inferior race. You can make the experiment with any calvaria. If you make a series of diagrams of skulls, placing them over each other, you may make them appear similar or dissimilar, according as you choose one or another fixed point for bringing them into relation. I should like to impress upon you that every dis-

covery of that kind should be received with caution and scrutiny. In my judgment, no skull hitherto discovered can be regarded as that of a predecessor of man. In the course of the last fifteen years, we have had opportunity to examine skulls of all the various races of mankind—even of the most savage tribes—and among them all no group has been observed differing in its essential characters from the general human type. Hence I must say that an anthropological teacher has not occasion to speak of a pro-anthropos except as a matter of speculation. But speculation in general is unprofitable. As Goethe says:

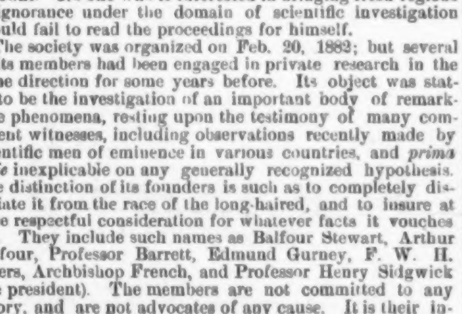
"Ein Kerl der speculirt
Ist wie ein Thier auf oeder Heide,
Vom boesen Geist umhergefuhrt."*

The day before I gave the address in Munich to which I have referred, Haeckel had gone so far as to propose to introduce into our schools a new system of religious instruction based upon the doctrine of the *Descent of Man;* and I think it necessary to guard against the danger of constructing systems of doctrines out of possibilities, and making these the basis of general education. Lastly, I have to refer to the geological aspect of the question. This is the most important aspect of it as treated by Darwin himself; and here we must recognize that the most important advance has been made in consequence of his ideas in our understanding of the progressive development of organs in the different classes of animals. From the earliest period, the organization of man has been regarded as an animal organization; and, therefore, from a zoological point of view, the body of man must be regarded as belonging to the animal kingdom. This I do not wish to deny. Ten years ago Liebig died, and I recall his memory at this moment to repeat one of his memorable sayings: 'Natural science is modest.' He means that science should be confined within the limits of observation. Every one who goes beyond that sphere becomes a transcendentalist, and transcendentalism has always been dangerous to science."

THE SOCIETY FOR PSYCHICAL RESEARCH.

THE four reports of the Society for Psychical Research which have been issued at intervals during 1882 and 1883 have now appeared in the form of a handsome volume, and it cannot be denied that they constitute a formidable body of evidence in favor of certain beliefs which have hitherto been looked upon with peculiar suspicion and distrust. A brief *résumé* of the testimony does not do it justice, for it derives its weight from the cumulative effect of its large amount. No one who is interested in bringing fresh regions of ignorance under the domain of scientific investigation should fail to read the proceedings for himself.

The society was organized on Feb. 20, 1882; but several of its members had been engaged in private research in the same direction for some years before. Its object was stated to be the investigation of an important body of remarkable phenomena, resting upon the testimony of many competent witnesses, including observations recently made by scientific men of eminence in various countries, and *primâ facie* inexplicable on any generally recognized hypothesis. The distinction of its founders is such as to completely dissociate it from the race of the long-haired, and to insure at once respectful consideration for whatever facts it vouches for. They include such names as Balfour Stewart, Arthur Balfour, Professor Barrett, Edmund Gurney, F. W. H. Myers, Archbishop French, and Professor Henry Sidgwick (the president). The members are not committed to any theory, and are not advocates of any cause. It is their intention to remove, if possible, what they justly say is a great scandal,—the existing state of absolute doubt as to whether phenomena testified to by a large number of generally credible witnesses, and of great scientific importance if true, can be properly authenticated or not. Their experiments are conducted with the most rigid precautions against deception and mistake, and, what is equally important, recorded with scientific precision. Six committees were formed for the consideration respectfully of thought reading, mesmerism, Reichenbach's experiments in regard to a peculiar sensitiveness to electric currents, apparitions and haunted houses, physical phenomena, and the collection and collation of existing materials bearing on the history of these subjects. Of their several reports, those of the committee on thought-reading, or thought-transference, as they call it later, are the most striking. The signification of the term "thought-transference" is limited to the communication of a vivid impression or a distinct idea from one mind to another, without the intervening help of the recognized organs of sensation. No account is taken, very naturally, of experiments in which there is physical contact between the persons concerned, or in which there is the slightest possibility of conveying information by sight or hearing. The extreme perfection to which a code of signals may be brought leads the committee to distrust all observations where two particular



ORIGINAL. REPRODUCTION.

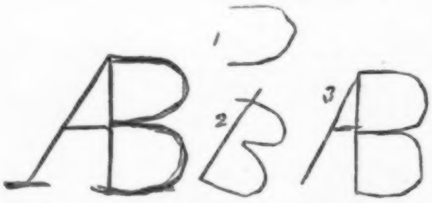
Inner circle begun at point marked +, and then carried round in one continuous line from left to right.

persons are necessary for the results obtained. Their most remarkable subjects for thought-transference have been found in a family in Derbyshire, that of Mr. Creery, a clergyman of high character, whose integrity has, as it happens, been exceptionally tested.

He has five daughters, of ages between eleven and eighteen, all thoroughly healthy, and as free as possible from morbid or hysterical symptoms. All of these children except the youngest are able to designate correctly, without contact or sign, an object fixed on in the child's absence—not, indeed, every time, but far more frequently than probability would allow as the result of chance. The child, on returning to the room, stands close to the door, amid absolute silence, with her eyes on the ground; often she does not return, but guesses from the adjoining room, with the door closed. The children have been experimented upon at their home by the committee, by Professor Barrett, by Mr. and Mrs. Sidgwick, and by Professor Balfour Stewart, as well as at the houses of different members of the committee at Cambridge and at Dublin. The objects guessed have been chiefly cards from a full pack, and numbers between ten and one hundred, but remarkable success has been obtained, also, in guessing names chosen at random, as in the following list:

William Stubbs.	'William Stubbs'
Sophia Shaw.	'Sophia Shaw.'
Timothy Taylor.	'Tom Taylor—Timothy Taylor.'
Isaac Harding.	'Isaac Harding.'
Albert Snelgrove.	'Albert Singrore—Albert Grover.'
Tom Thumb.	'Tom Thumb.'
Cinderella.	'Cinderella.'
Chester.	'Manchester—Chester.'
Pipe.	'Plate—paper—pipe.'
Cork.	'Fork.'
Corkscrew.	'Corkscrew.'
Tongs.	'Fire-irons—poker.'

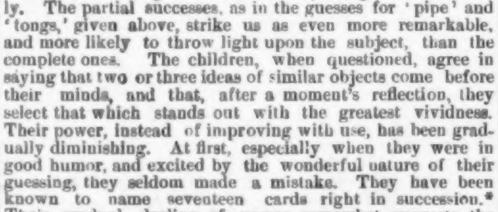
From the summary of results, it appears that, out of every 610 trials with playing cards, there were 118 correct guesses on the first trial, and 76 on the second; or that, counting the first trial only, there was 1 correct guess out of every 5·17 instead of 1 out of every 52, as would be given by chance



ORIGINAL. REPRODUCTION (THREE ATTEMPTS).

alone. Of 260 numbers, 68 were guessed correctly the first time, and 35 the second time, or, on the first trial, 1 out of every 3·82; whereas from chance would have given only 1 out of every 90. Where the trial is counted as a failure, it frequently happened that the suit, or the number of pips of the card, or one figure of the number, was guessed correctly. The partial successes, as in the guesses for 'pipe' and 'tongs,' given above, strike us as even more remarkable, and more likely to throw light upon the subject, than the complete ones. The children, when questioned, agree in saying that two or three ideas of similar objects come before their minds, and that, after a moment's reflection, they select that which stands out with the greatest vividness. Their power, instead of improving with use, has been gradually diminishing. At first, especially when they were in good humor, and excited by the wonderful nature of their guessing, they seldom made a mistake. They have been known to name seventeen cards right in succession.* Their gradual decline of power somewhat suggests the disappearance of a transitory pathological condition. On the other hand, a larger number of good subjects has been found than there was reason at first to look for.

Much more remarkable than experiments with cards or numbers, where there is at least an appreciable chance of getting right by accident, are those in which an impression of a drawing is conveyed from one mind to another, without contact, or any conceivable use of the ordinary means of communication. In these experiments, Mr. Blackburn, an associate of the society, who is described as a very painstaking and accurate observer, is the operator; and Mr. Smith, a young mesmerist of Brighton, is the subject. Mr. Smith is seated, blindfolded, at a table in one of the rooms of the society; paper and pencil are within his reach, and a member of the committee is seated by his side. Another member of the committee leaves the room, and outside the closed door draws some figure at random. Mr. Blackburn is now called out, the door is closed, and the drawing is held before his eyes for a few seconds. Closing his eyes, Mr. Blackburn is led back into the room, and placed, standing or sitting, behind Mr. Smith, at a distance of some two feet from him. After a brief period of intense metal concentration on Mr. Blackburn's part, Mr. Smith takes up the pencil, and, amid the absolute silence of all present, reproduces as nearly as he can the impression he has received. Mr. Blackburn keeps his eyes closed (sometimes they are bandaged as an aid to concentration); and he has not touched Mr. Smith, and has not gone in front of him, or in any way within his possible range of vision, since he re-entered the room. Sixty pages of the drawings and reproductions are given—facsimiles of



ORIGINAL. REPRODUCTION. ORIGINAL AS MR. BLACKBURN REMEMBERED IT.

the originals, from which they have been photographed on the wood blocks. The reproductions are rude copies of the drawings such as a child might make, blindfold, of a picture he had just seen; but in every case the resemblance is recognizable, and sometimes it is very exact. A particularly good one was made, when, with a view of removing all doubt as to possible auditory communication, Mr. Smith's ears were stopped with putty, a bandage was tied round his eyes and ears, a bolster-case was fastened over his head, and over all was thrown a blanket which enveloped his entire head and trunk; and Mr. Blackburn sat behind him as still as it is possible for a human being to sit who is not concentrating his attention on keeping motionless to the exclusion of everything else. To profit by a code of signals in this case, Mr. Smith would have had to extract the putty from his ears, and still smothered in bolster-case and blanket to detect periodic variations in Mr. Blackburn's breathing imperceptible to the committee, and to interpret them into a description of a very irregular figure. This hypothesis seems to the committee an extreme one, but they intend to meet it by still further varying the conditions of future experiments.

The record is given of another set of experiments made upon two young ladies at Liverpool, under the strictest conditions, by Mr. Guthrie and Mr. Birchall. The following were among the guesses:

A gold cross.	'It is yellow—it is a cross.'
An egg.	'Looks remarkably like an egg.'
A penholder, with thimble inverted on the end.	'A column, with something bell-shaped turned down on it.'
Letter Q.	'Q.'
A dark-crimson apple.	'Is it round—a dark-red shade—like a knob of a door?—It is an apple.'
A key.	'A little, tiny thing, with a ring at one end, and a little flag at the other, like a toy-flag.' Urged to name it, replied, 'It is very like a key.'
A pair of scissors standing open and upright.	'It is silver?—No: it is steel—it is a pair of scissors standing upright.'

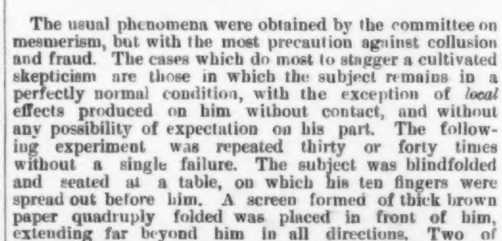
ORIGINAL. REPRODUCTION.

Mr. Smith had no idea that the original was not a geometrical diagram. He added line *b* some time after he had drawn line *a*, 'seeing a line parallel to another somewhere.'

The usual phenomena were obtained by the committee on mesmerism, but with the most precaution against collusion and fraud. The cases which do most to stagger a cultivated skepticism are those in which the subject remains in a perfectly normal condition, with the exception of *local* effects produced on him without contact, and without any possibility of expectation on his part. The following experiment was repeated thirty or forty times without a single failure. The subject was blindfolded and seated at a table, on which his ten fingers were spread out before him. A screen formed of thick brown paper quadruply folded was placed in front of him, extending far beyond him in all directions. Two of his fingers were then selected by one of the committee, and slightly pointed out to the mesmerizer, who proceeded to make very gentle passes over them; and to prevent the communication to the subject of a sensation of change of temperature or a current of air, a member of the committee made, as nearly as possible, similar passes over two others of his fingers. After a minute or less, the two fingers mesmerized proved to be perfectly stiff and insensible; the points of sharp instruments might be plunged deep into them, or a lighted match might be applied to the sensitive region around the nail, without producing a sign or a murmur.

It is difficult to suppose that an ordinary youth, sitting with relaxed limbs in quiet unconcern, would be able to control, by the exercise of his will, every sort of reflex start or twitch when a naked flame is applied to one of the most sensitive parts of his person. To meet such an objection, however, the experiments were repeated with other subjects with equal success—one of them a delicate woman, whose shrinking from pain was such that the prick of a fork on one of her unmesmerized fingers would cause a half-hysterical cry. The hands of the subject may even be mesmerized when he is in the mesmeric sleep; and then the usual clap and call restore him to consciousness, but do not permit him to remove his hands from the sofa, to which they seem to be glued, until after they have been separately released.

We pass over the report of the Reichenbach committee, of the literary committee, and of the committee of haunted houses, but not because they do not contain a great deal of



ORIGINAL. REPRODUCTION.

very interesting and striking matter. The addresses of the president, too, are models of clear, careful, and forcible writing; and the proceedings as a whole cannot fail to produce a strong effect upon a reasonably unprejudiced reader, especially when it is considered that all this is in addition to the varying amount of testimony and experience that has been for years in the possession of nearly all of us. In no other subject has there been such a long dispute over the reality of the phenomena; even the witnesses to globular lightning have gained credence for themselves at last. No other subject, as is perfectly natural, has been so inextricably mixed up with fraud and chicane, and has fallen, in consequence, under such a weight of obloquy. There has usually been, besides, a peculiarly 'unwashed' flavor about the possessors of these mysterious powers which are denied to people in general. The traveling mesmerizer has not been an attractive specimen of humanity, and to that fact has been allowed more than its due effect. In other undecided scientific questions, weight of authority has counted

* "A speculating fellow is like a beast on a barren heath led about by the Evil Spirit."

* The chance of doing which, by accident, is as 1 to 52^{17}.

for something, but not the weight of a man's family connections. Even when it was said that such unexceptionable witnesses as De Morgan and Wallace and Crookes had become convinced that certain facts not generally admitted were really facts, one could not help believing that they differed in some way from the ordinary sane scientific man, and that some peculiar crookedness of mental vision was the source of their strange belief. Another refuge of incredulity has been national and sectional distrust; it was chiefly outside of the centers of learning that such things went on. Mr. Sidgwick was once told by a German, that they happened only in England or America, or France or Italy, or Russia or some half-educated country, but not in the land of *geist*. If this society does not at once convince all the world of the truth of its phenomena, it has at least accomplished the feat of suddenly elevating them into the region of respectability; and hereafter any one can admit his belief in them without shamefacedness. Now that mesmerism and mind-reading have ceased to be exclusively the property of traveling shows and after-dinner entertainments and have be-come a subject of experiment in laboratories, it is to be hoped that their extent and limitations will be speedily defined, and that the vagueness and haze in which they have hitherto been enveloped will soon be replaced by definite knowledge.—*Science.*

THE BASSET HOUNDS.

The twenty-third exhibition of sporting and other dogs under the direction of the Kennel Club was opened at the Crystal Palace on July 1, with 1,286 entries, two-thirds of which belonged to various descriptions of terriers; but there were a large number of sheep dogs, and nearly a hundred St. Bernards. The mastiffs, Newfoundlands, and Danish boar hounds were remarkably good. The arrangements for tenting, benching, and feeding were made by Spratt's Patent Dog Biscuit Company, of Southwark. Among the animals whose novelty attracted most attention were the Basset hounds, which are shown in our illustration, not as they were placed at the exhibition, but in a home drawing room scene. This breed of dog was first imported by Mr. Millais, and shortly afterward by Lord Onslow; but until Mr. G. R. Krehl took up the breed it was but little known in England. It is now rapidly coming into public favor; and this is mainly due to the perseverance and enterprise of Mr. Krehl, who secured the best specimens of the breed in France, and from these have been bred the most celebrated of our prize winners, which are undoubtedly quite equal, if not superior, to any now to be obtained on the Continent. Although, for some years, these hounds were only to be found in a few kennels, fresh admirers are continually taking to keep this breed, which threatens to rival in popularity that quaint little dog the dachshund. For hunting, the Basset hounds have few if any equals, their powers of scent being highly esteemed by those who have been fortunate enough to have seen them at work. The most prized strain is that of Count Couteulx, and the best dogs now in England are "pure Couteulx."—*Illustrated London News.*

THE BASSET HOUNDS.

During sudden changes of temperature, siphons containing mineral water become dangerous. A rapid rise of the thermometer will sometimes increase the pressure 100 per cent. and produce violent explosion.

THE LAWS OF VOLUME AND SPECIFIC HEAT.

The following interesting communication from Mr. Samuel E. Phillips recently appeared in *Nature*. The facts as to the variation of specific heats of gases will be seen to be of much importance. The former, known as the "law of Avogadro," implies that any given volume at the same temperature and pressure must contain the same number of molecules. It includes the law of Chasles, viz., equal expansibility for equal increments of heat; and the law of Boyle or Mariotte, that the volume of any gas must vary inversely as the pressure. The other is that of Dulong and Pettit; and as the former necessitated equal volumes, so this latter implies constant heats for parallel conditions. But, finding that few elements approximated this law, it was an early device to double, treble, or quadruple the old atomic weights to secure a supposed uniformity; and thus the law found this expression, viz., that the specific heat of any solid element would prove to be a measure of its atomic quantity. This, put in plausible fashion, will be the stock instruction of the superficial books for some time to come; but in the higher circles of chemical life it is being admitted more and more that a great change has come over the spirit of this dream. Departures from the normal 6·4 are no longer attributed to errors of observation, and that constant is replaced by a range of 5·5 to 6·9; while, to keep within this, M. Weber has proved that the doubled carbon equivalent must be tested at a range of temperature exceeding 1,000 deg. C. He has found that within the limits of —50 deg. and 600 deg. its heat value increases sevenfold! Well indeed may he say, "The idea that temperature can be overlooked must no longer be entertained;" also, "That the specific heats are not generally expressed by constant numbers; the physical condition of the elements influences their specific heats as much as their chemical nature."

These be great admissions from one of the highest authority, but they are as nothing compared with the new demands of physical chemistry. Mr. J. T. Sprague, an able and determined new chemist, has been the first in England to challenge attention to the recent researches of M. Berthelot, L. Troost, and others of the very highest chemical authority. In a recent paper he admits that the new results "strike at the root of the most favorite chemical doctrines of the day, doctrines which are the foundation of the modern atomic weight and molecular theory, and consequently of the doctrines of atomicity, and the complicated molecular theories which have been based upon the supposed atomicity and specific bonds of different atoms." The laws of Avogadro, and Dulong and Pettit are offshoots of one principle, and one really implies the other. If true, it would follow that the atomic heat must be the same for all substances, or, if otherwise, the same quantity of heat would not produce equal expansions; also that the specific heats must be equal at all temperatures, or equal quantities of heat would act differently at different temperatures, or else it must vary equally for all gases, or they would expand unequally for equal quantities of heat.

Now, it is a misfortune for these laws that none of these conditions subsist over wide areas. As a consequence of the two laws, an air thermometer should measure all temperatures by equal rates of expansion, and a given expansion should correspond to fixed quantity of heat; such a thermometer also read equally if filled with any other perfect gas. In other words, these laws can only be true if the relation between the weight and volume of different gases be constant, and if the heat absorbed in producing a given change of volume is equal at all temperatures—that is, if the specific heat is constant. These conditions are practically fulfilled by air O, N, and H between 0 deg. and 200 deg. Cent., so that the scale of temperature derived from the change of volume is the same as the scale derived from quantities of heat; but between 200 deg. and 4,500 deg. there is a gradual growth of changed conditions which proves fatal to both laws, and there is apparently an absorption of energy which does not appear either in the form of expansion or of sensible heat as temperature. At this high stage the specific heat of some of the simple gases has increased threefold, while some gases have a greater rate of expansion than others. The same thing occurs with other simple gases, but at a much lower temperature, as, even with 0 deg. and 200 deg., where dissociation cannot be entertained, chlorine and other halogens differ considerably from N or H, and at 1,600 deg., if an air thermometer indicated 1,600 deg. for a given expansion, a chlorine one would register by expansion 2,400 deg. for an equal temperature, though with a much greater absorption of heat by the chlorine. This difference is dependent on the fact that at 1,600 deg. the comparative density of chlorine has diminished one-third, or, in other words, that its volume, as compared with H, instead of being 1, has become 1·5; or, to put it in another way, that under these conditions the specific heat of Cl is threefold that of H. Quite apart from these extreme cases, the specific heat is never a constant value; it takes more heat to raise a given weight of substance 1 deg. at one temperature than another. The specific heat increases with temperature, but differently for different substances:

	0 deg. to 100 deg.	0 deg. to 300 deg.
Iron	=0·1098	0·1218
Platinum	=0·0335	0·0343
Mercury	=0·0330	0·0350

The differences here are both distinct and small, but Be (glucinium) increases twofold within a moderate range, and we have seen that between —50 deg. and 600 deg. carbon increases its specific heat sevenfold, or, as Mr. Sprague expresses it: "The heat relation of each substance is described by a particular curve; and the small differences observed in some cases are not errors, but actual differences of the several curves; and where there is approach to identity it is accidental, due to the temperature of observation being within a limit at which the curves are near their commencement, and have barely begun to separate." However tempting or fashionable it may be to rush into hypothetic explanations of half-digested truths, yet I have taken some pains to keep within facts, which are in some respects incipient and but little understood. If the casual differences in the production of light and sound had been fairly or patiently entertained, the "luminiferous ether" would never have been invented, which now crosses our path, as an "opaque fact, stopping the progress of further knowledge."

If a little more humility and patient had been evinced in respect of the expanding facts connected with gaseous volumes and specific heats, the old equivalents would never have been doubled, trebled, or quadrupled, to mar the symmetry of a beautiful science. I quite agree with M. Troost, who, in repudiating the hasty references to dissocia-

tion, etc., observes: "The only consequences which necessarily flow from the experiments at high temperatures, or at low pressures, are that the coefficient of expansion is variable with the temperature, or that the coefficient of compressibility varies with the pressure." Also with the final conclusion of M. Berthelot: "The only law absolutely and universally applicable to the elements is the invariability of the relations of weight according to which they combine. This notion, and that of the energy brought into play in their reactions, are the sole and only firm foundations of chemical science."

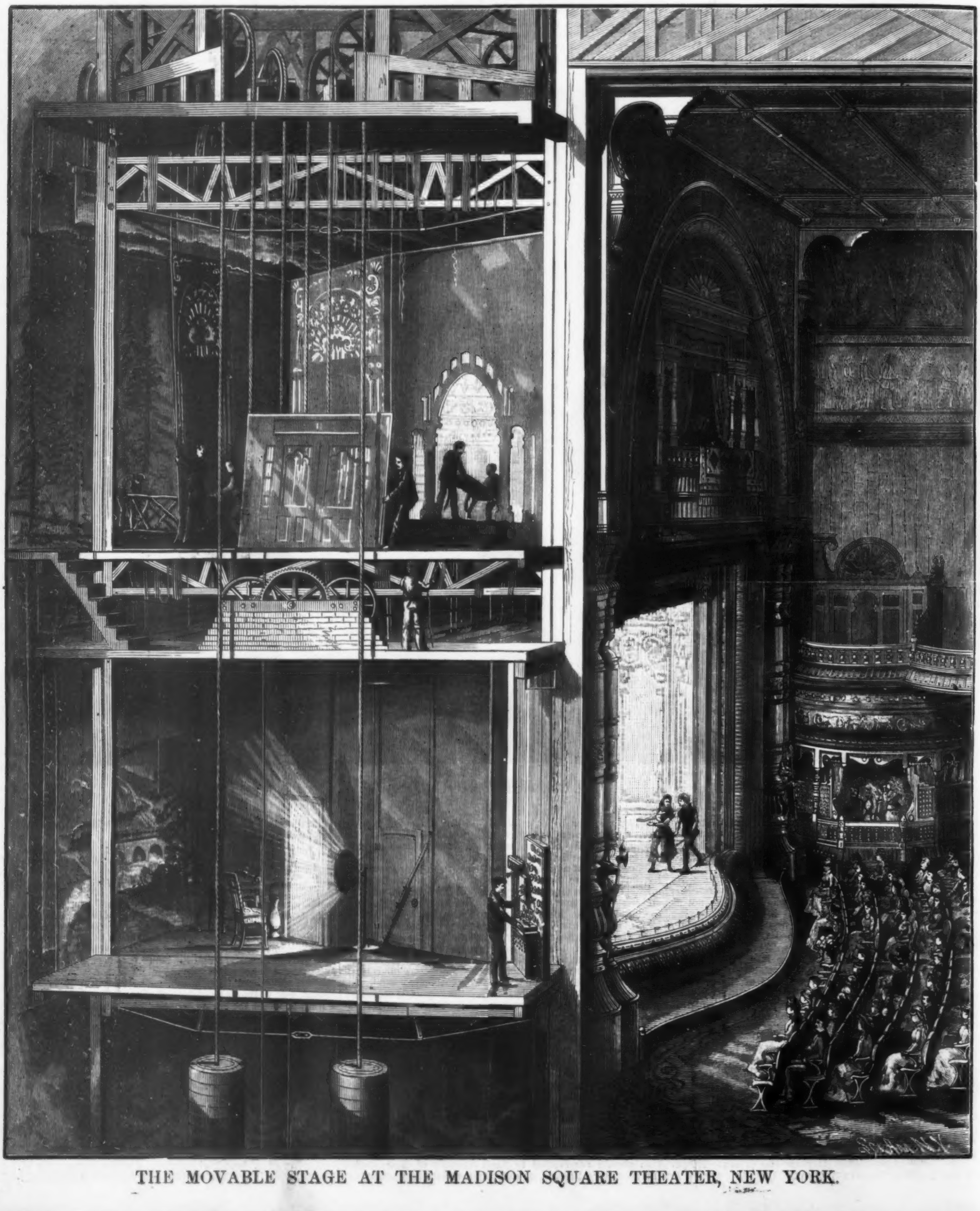
MOVABLE THEATER STAGES.

FOR a few years back, or since Richard Wagner first brought out the Niebelungen-Lied at Bayreuth, the tendency in first class theaters and opera houses has been to greater elaboration of the scenic details, the more vivid representation of the surroundings connected with the plot of the play or opera. It was on this account that a temple was specially built in which to present the best illustration of the "music of the future." Thus also has Mr. Henry Irving obtained phenomenal success in England, and won great favor here, by the hard study and unstinted labor he gives to the perfecting of the scenery and stage equipments for the setting of his plays. Yet in all of the additional work now demanded of stage managers, there has been but little aid extended by inventors, and but few theater appliances patented. The illustration we herewith present, however, affords a view of an improvement, practically tested at the Madison Square Theater in this city, which has not thus far been put in operation in any other theater, and which would seem to afford every facility for the elaborate setting and changing of scenes without necessitating long "waits" on the part of the audience.

Our illustration affords a view of two theatrical stages, one above another, to be moved up and down as an elevator car is operated in a high building, and so that either one of them can easily and quickly be at any time brought to the proper level for acting thereon in front of the auditorium. The shaft through which this huge elevator moves up and down reaches 114 feet from the roof to the bottom of the cellar below, and the stages so moved are built up in a compact, two-floored structure of timber strapped with iron, knitted together by truss beams above and below, and substantially bound by tie and tension rods. The whole makes a structure fifty-five feet high, twenty-two feet wide, and thirty-one feet deep, weighing, as stated by the management, forty-eight tons, and having a vertical movement of 25 feet 2 inches at each change.

This immense contrivance is suspended at each corner by two steel cables, each of which would be capable of sustaining far more than the whole load, and these cables pass upward over sheaves or pulleys set at different angles, thence downward to a saddle, to which all are connected. Connected to this saddle is a hoisting cable, attached to a hoisting drum, by the rotation of which the stages are raised and lowered. Practically, only forty seconds are required to raise or lower a stage into position, and four men at the winch are as much as is ever required. This movement is thus easily effected, without sound, jar, or vibration, from the nice balancing of the stage and its weight with counterweights, which are suspended from the saddle to which the cables supporting the weight of the stages are attached.

In combination with each of these movable stages are borders and border lights arranged to throw light down upon the stage, and so connected with flexible gas tubes as to be readily turned on and off; each stage has its trap floor, with traps and guides and windlasses for raising the traps—the space for this, and for operating the windlass under the top stage, being about six feet. Our illustration shows that, while the play is proceeding before the audience, another



THE MOVABLE STAGE AT THE MADISON SQUARE THEATER, NEW YORK.

scene is being arranged by the assistants on the upper stage, to be followed, when this is lowered, by similar preparations for the succeeding scene, should this be necessary, on the stage that will then be twenty-five feet below.

Independent of the peculiarity of the movable stages, there were many innovations on former practices in the fitting up of this, one of the pleasantest of New York's theaters, some four years ago. Fresh air is forced over steam radiators and through pipes to every part of the floor of the auditorium, or it is cooled and sent through the same pipes in the summer, but under such a system that it can conveniently at any time be shut off from any section; there is also a ventilating shaft in the roof through which the vitiated air is carried off, so that the whole atmosphere of the house is renewed, it is claimed, six times in every hour. [The whole matter of the ventilation of the Madison Square Theater was fully explained, with illustrations, in SCIENTIFIC AMERICAN SUPPLEMENT, No. 250.] Another noticeable feature is that the orchestra, instead of occupying the usual position just below and in front of the stage, is placed in a balcony at the top, just over the stage opening, in the proscenium arch, thus keeping the view of the stage from the parquette unobstructed.

Not a little fun was made of Mr. Steele Mackaye, in 1879, when he obtained his patent for and proposed to build the first movable stage, as here represented. The details of Mr. Mackaye's patent were not as completely worked out, although the idea was there, as they subsequently were by Mr. Nelson Waldron, the stage machinist, who elaborated the system and obtained a subsequent patent therefor, under which these movable stages have since been so successfully and satisfactorily operated at the Madison Square Theater.

The architecture of this theater, by Messrs Kimball and Wisedell, and the decoration, by Mr. Louis C. Tiffany and Mrs. Wheeler, have received wide and deservedly high praise; many features were novelties, but there was nothing inappropriate or commonplace.

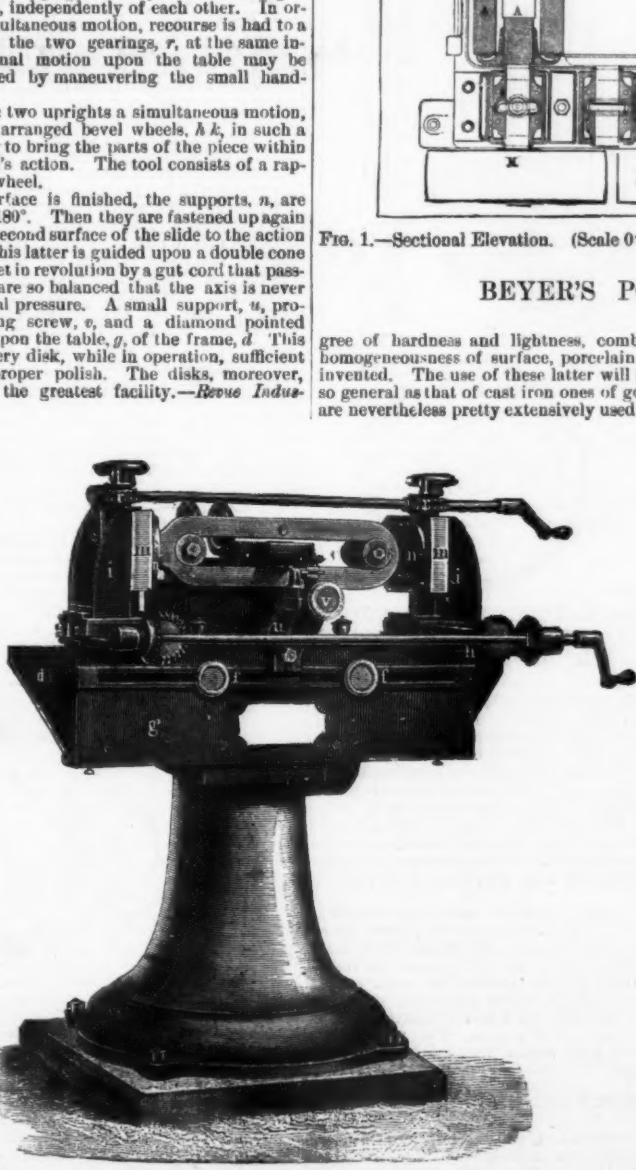
MACHINE FOR POLISHING THE SLIDES OF LOCOMOTIVES.

THE machine represented in the accompanying cut has been devised and constructed by Messrs. Oppenheim & Co., with a view to facilitating the process of polishing locomotive slides—an operation that takes some little time when performed in the usual way, but which may be done very rapidly with this device after the pieces have been tempered.

The slide to be polished is firmly fixed upon two short rods connected with the supports, *n*, and in such a way that the internal surface upon which the tool is to act shall be exactly parallel with the table, *g*. The two uprights, *i*, to which the supports, *n*, are bolted, are capable of being made to approach or recede from each other, according to the dimensions of the piece to be polished. After they have been separated the desired distance, the slide is fixed at the proper height by acting upon the small hand wheels, *q*, which are arranged above the uprights and permit of raising or lowering the slides, *m*, independently of each other. In order to give them a simultaneous motion, recourse is had to a winch which actuates the two gearings, *r*, at the same instant. The longitudinal motion upon the table may be modified and regulated by maneuvering the small hand-wheels, *f*,

In order to give the two uprights a simultaneous motion, the constructors have arranged bevel wheels, *h k*, in such a way as to make it easy to bring the parts of the piece within the radius of the tool's action. The tool consists of a rapidly revolving emery wheel.

As soon as one surface is finished, the supports, *n*, are loosened and revolved 180°. Then they are fastened up again in order to submit the second surface of the slide to the action of the emery wheel. This latter is guided upon a double cone in a long bearing and set in revolution by a gut cord that passes over pulleys which are so balanced that the axis is never submitted to any lateral pressure. A small support, *u*, provided with a regulating screw, *v*, and a diamond pointed dressing tool, is fixed upon the table, *g*, of the frame, *d*. This serves to give the emery disk, while in operation, sufficient grain to secure the proper polish. The disks, moreover, may be changed with the greatest facility.—*Revue Industrielle.*



MACHINE FOR POLISHING THE SLIDES OF LOCOMOTIVES.

BEYER'S PORCELAIN-CYLINDER FLOUR MILLS.

BEFORE founders were able to furnish crushing cylinders or converters of tempered cast iron having the necessary degree of hardness and lightness, combined with a perfect homogeneousness of surface, porcelain cylinders had been invented. The use of these latter will probably not become so general as that of cast iron ones of good quality, but they are nevertheless pretty extensively used and are well adapted to many situations. The invention of porcelain cylinders appears to be due to a Mr. Weymann, a Swiss constructor. In principle, the two porcelain converting cylinders are of the same diameter. The bearings of one of them are stationary, while those of the other are pulled by a regulatable spring toward the first cylinder in such a way as to cause the grits to undergo a sufficient amount of pressure to separate the coarse flour without flattening them. When, through any cause whatever, the material is difficult to crush, the retractile cylinder separates from the other. On another hand, this cylinder can never touch the fixed one, even when the stream of grits that is flowing from the hopper is arrested. The velocities of the two cylinders are to each other as 4 is to 3, and it is the retractile one that revolves the slower. Owing to this difference in velocity, the operation is just as if the rapid cylinder were revolving with a sliding motion upon the other. The consequence is that the grits, during their passage between the cylinders, are submitted under pressure to a crushing which effects a disintegration, without injuring the flour through too great a pressure. The Messrs. Beyer have improved the primitive system of conversion by porcelain cylinders, by adding to the normal or vertical crushing of the grits a longitudinal or horizontal one. This they obtain by a to and fro motion given the slow cylinder. This double motion has the same effect as a pestle turned around by hand in the bottom of a mortar, and is well adapted for disintegrating the grits, even under a slight pressure.

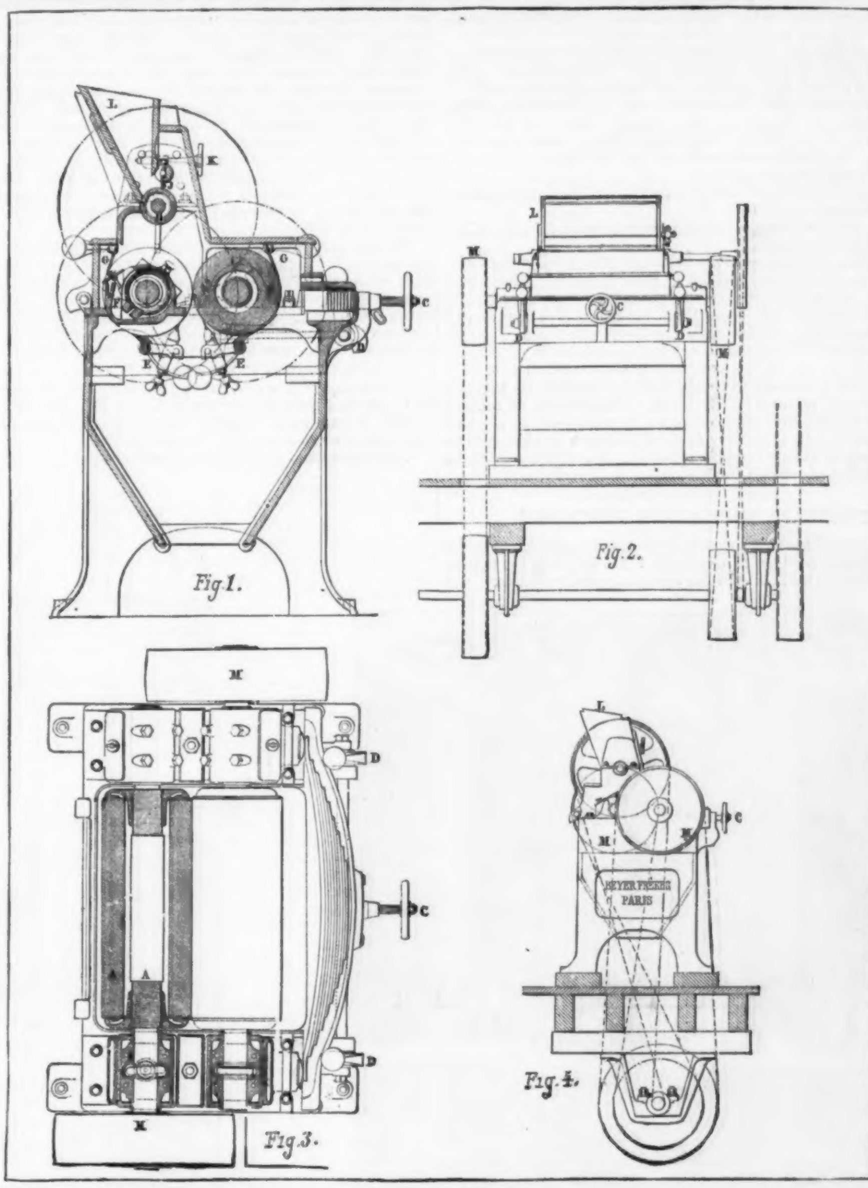


FIG. 1.—Sectional Elevation. (Scale 0·08 m. = 1 m.) FIG. 2.—Front Elevation. (Scale 0·04 m. = 1 m. FIG. 3.—Plan. FIG. 4.—Profile.

BEYER'S PORCELAIN CYLINDER FLOUR MILL.

These new cylinders are especially well adapted for the regrinding of grits derived from low or half-high grinding by stones; but they can also be as well employed for grits derived from high grinding by mills, by cast iron crushing cylinders, and by mills or disks of tempered cast iron, etc.

In the accompanying engraving we give the details of a No. 4 Beyer mill, having a pair of cylinders of great length.

Each of these cylinders is driven by a belt, one to the right and the other to the left, passing over pulleys keyed to an intermediate shaft that revolves in pillow-blocks situated under the flooring. The feed-cylinder, which revolves slowly, is driven by a crossed belt that starts from a very small pulley, keyed upon the same shaft, and reaches a large pulley fixed to the extremity of the shaft of the feed cylinder.

A A represents the porcelain cylinder, which is fixed upon its shaft by means of two threaded heads forming nuts. The junction of the two parts is made after heating the metal, so that the shrinkage of the steel shaft on cooling shall tighten the heads against the porcelain to such a degree as to render them inseparable therefrom.

B represents the pillow-block uncovered and one of the journals of the cylinder with the eccentric hoop fixed above for giving the transverse to and fro motion. This hoop revolves in a bronze bearing.

C represents a tightening screw, which operates through

the center of the spring in order to regulate its tension. The two extremities of this spring bear against the pillow-blocks of the movable cylinder in such a way as to thrust them parallelly against the fixed one.

D is a lever called a manipulator, which permits of the movable cylinder being instantaneously pulled back without affecting the regulation of the spring.

E E are brushes and scrapers, with supports and counterpoises, placed beneath each cylinder. They serve to clean the latter of any fatty matters that might adhere thereto.

F is an automatic lubricating cup. A lubricating ring placed upon the journal of the cylinder leads oil continuously to the said journal, whose lubrication is rendered complete by two wicks that suck the oil up into a reservoir placed behind the pillow-block.

G G are scrapers of oblique section, with counterpoises, fixed over each cylinder.

H is a striated cylinder placed over the porcelain cylinders in order to feed them.

L is a hopper that receives the conduit that leads the grits.

M M are the driving pulleys of each cylinder. The quantity of grits per hour that can be passed through the converting cylinders depends upon their nature, and consequently varies according to the size, hardness, etc. Mill No. 3, which has shorter cylinders, crushes about from 20 to 150 kilogrammes, and the power absorbed is about that of 1½ horse. No. 4 crushes from 250 to 300 kilogrammes with an absorption of about 3 H. P. Such expenditures of motive power suppose the lubrication to be well performed, and the spring to be moderately taut—the Beyer double motion permitting of the conversion being effected with a minimum of pressure.—*Le Génie Civil.*

TOSELLI'S SUBMARINE EXPLORER.

THE remarkable apparatus that we are going to make known to our readers is designed for exploring the depths of the ocean, and is due to the able and bold engineers, the Messrs. Toselli—father and son—who have surrendered it to a society located at Nice. Mr. Toselli, Jr., had already had an apparatus constructed analogous to the one which we here figure, and with which he had been enabled to descend to a depth of 70 meters. It was after this first completely successful attempt that the construction of the present great machine was entered upon. This apparatus is designed for descending from 200 to 250 meters below the surface.

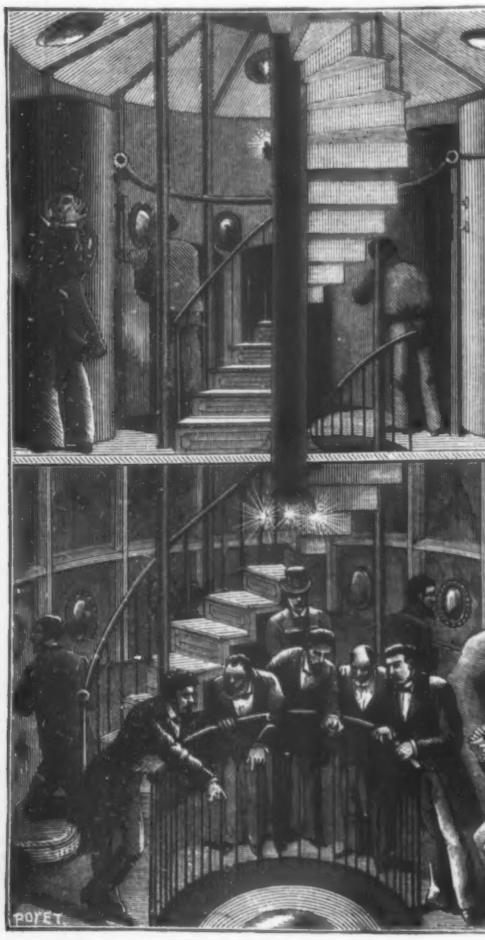


FIG. 1.—INTERIOR VIEW OF THE NEW SUBMARINE EXPLORER.

It is the design of the engineers who are pursuing this new line of research not to rest here, but to construct, it is said, a submarine explorer that shall be capable of reaching depths of 1,000 meters. These apparatus will after a fashion be for the ocean what the captive bottom is for the atmosphere. But, without speaking further of the future, let us come down to the present and examine the device that has been constructed.

The present apparatus is called the "Neptune." Fig. 1 shows the aspect of the two interior chambers, with the travelers that they are capable of holding, while Fig. 2 gives a longitudinal section and a plan.

The apparatus is formed of three very distinct parts, separated by disks that rest upon angle-irons. These disks are connected with each other by columns and uprights. The upper disk is surmounted with a cylinder of smaller diameter in which is fixed the stairway that allows the interior to be reached. The first chamber that is entered (at the top) belongs to the mechanicians, and it is here that are collected all the apparatus that serve for maneuvering. All around are seen reservoirs of air compressed to 30 and 40 kilogrammes, which serve, when they are operated by the opening of cocks, to diminish the weight of the Nepture, by driving out the water introduced into the ballast chamber, and to actuate the pump that raises the cover that closes the entrance of the neck for descending. This first chamber contains, in addition, telegraphic and telephonic apparatus that connect the explorer with the yacht that accompanies it. The Neptune is attached to the vessel by cables which are fastened to two lugs fixed to the cylinder. The machine chamber likewise contains the pressure gauges, thermometers, and other measuring apparatus. The chamber beneath is designed for the exploring party. Its inner circumference is provided with 14 seats, placed under as many bull's-eyes or lenses, which permit of examining the surroundings of the apparatus. A large lens in the center permits the ocean bottom to be examined. This apartment, like the other, is provided with electric lamps, which give out a bright light.

Finally, the lowermost division is the ballast and light chamber, and is the principal part of the invention. This part of the apparatus is arranged in such a way that more or less water may be introduced therein, so as to allow the apparatus to descend. If it be desired to ascend, this water is expelled by means of compressed air, when the lightened apparatus will rise to the surface. Five bronze electric lamps illuminate the surroundings of the explorer with their powerful rays. Finally, at the sides of the Neptune there are placed leaden weights, which are held in sheaths, and which, in case of an accident, can be freed from within the apparatus, so as to permit of a quick ascent.

The apparatus, at the moment of its descent, is closed by a steel cover, 60 millimeters thick, which is provided with a groove into which a ring is inserted, and in the bottom of which a rubber joint is held. This cover weighs 700 kilogrammes and is maneuvered by a pump.

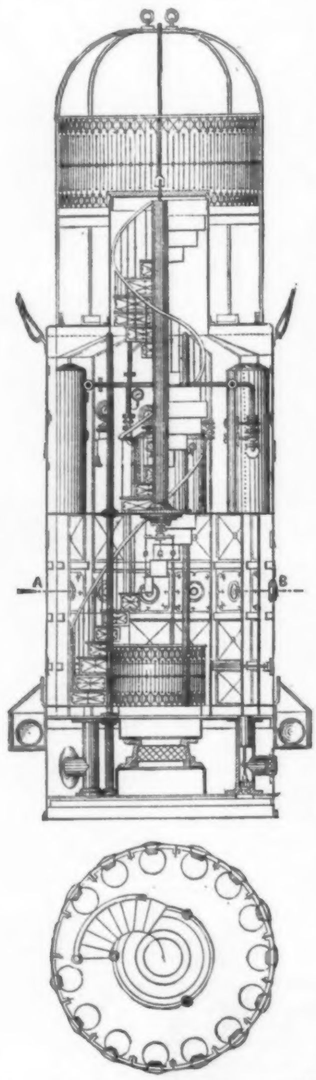


FIG. 2.—LONGITUDINAL SECTION AND PLAN OF THE EXPLORER. (One-eightieth actual size.)

This submarine explorer will find numerous applications: It may be used in soundings, and lend its aid in the construction of lighthouses or maritime works. The repairing of ships may be more easily executed by its aid; it will serve to facilitate the laying of torpedoes; and—who knows?—perhaps it will some day permit genuine submarine voyages to be taken, such as have hitherto been possible only by reading Jules Verne.

The first trial of the explorer was made on Saturday, June 14, in the bay of Villefranche-sur-mer, near Nice. This experiment showed the necessity of introducing intothe apparatus a few modifications of the compressed air reservoirs. So further trials will be retarded for some weeks. The dimensions of the explorer are as follows: diameter, 3 meters; height, up to the neck, 6·5 meters; diameter of the neck, 1·31 meters; length, 1·68 meters. The neck is surrounded with a balcony that makes the total height about 10 meters.—*La Nature.*

DR. EDWARD VANDERPOOL, of New York, recommends Fowler's solution of arsenic in neuralgia of the stomach, in six to ten drops three times per day. His experience with it appears to have been highly satisfactory in the cases reported.—*Independent Practitioner.*

NOTES AT THE MISSOURI PACIFIC SHOPS.

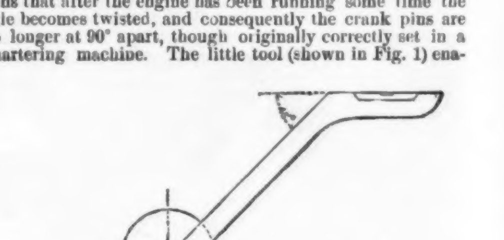
THE principal shops of this enormous system of railroads are situated at St. Louis, and are of but moderate size, and in fact the machine and erecting shop was built some fourteen years ago for the original Missouri Pacific Railroad, and has not been enlarged since. In a system covering so large a territory, the different divisions have a somewhat independent organization, the various shops being each capable of executing some repairs, and as all extensive repairs are not executed at one central point, the principal shops are not as large as might be expected. The whole Missouri Pacific system, though embracing some 6,000 miles of line, has only 733 locomotives, and the St. Louis shop virtually serves as headquarters for about one-third of this mileage and a corresponding number of engines, or only a few more than are employed on the Manhattan Elevated Railroad in New York, working but 32 miles of road.

The good organization of the shops enables them not only to keep the engines in repair, but to execute a large amount of work outside the usual run of locomotive building. Smith's hearths, drill presses, etc., are made here quite extensively as a regular article of manufacture, and are supplied to the various shops along the line.

The system of making the various parts of an engine to a standard by means of a liberal use of templates, gauges, reamers, etc., is comparatively easily carried out by a firm which makes only new engines, and does not execute any repairs, but becomes a work of constant difficulty in a railroad shop where the engines of half a dozen different makers have to be kept in repair. Even where such engines are made from the same drawings, and are nominally alike in all particulars, it will be found that they are built from gauges and templates which differ just sufficiently to prevent the parts of an engine by one maker from being interchanged with corresponding parts of an engine built by another maker. A master mechanic has constantly to struggle against this difficulty, which delays and enhances the cost of locomotive repairs. The collection of reamers, cutters, special taps, and numerous other appliances for repairing the various parts of locomotives, and keeping them to a standard size, is unusually complete in the Missouri Pacific shops, and a few of these devices are described further on.

The proper size of the crank pins in the wheel fit is ascertained by a couple of ingenious and accurate little contrivances. The hole in the wheel is gauged by means of an adjustable gauge, set out against the walls of the crank pin hole by means of right and left handed thumbscrews. The gauge when set is drawn out of the hole, and calipered at each end by a pair of differential calipers. These calipers can be set by means of thumb screws, but in order to secure greater fineness of adjustment, a small plunger works through one foot of the calipers, and serves as a touch piece. Thus the size of the object is the distance between the face of this touch piece and the other leg of the calipers. The touch piece is connected to the short arm of a bell crank lever, the long arm of which is a needle moving on a scale cut on the calipers near the head. Each division in this scale is equivalent to $\frac{1}{1000}$ inch diameter of crank pin. It was found by experiment that a crank pin $\frac{8}{1000}$ inch larger in diameter than the hole would remain tight during service, while a greater difference in size tended to burst the hub, and of course a smaller difference was insufficient to keep the pin firmly in the wheel. It was therefore obviously desirable that every crank pin should be $\frac{8}{1000}$ of an inch larger in diameter in the wheel seat than the hole in the wheel. As the crank pin holes in engines made from the same drawings but by different makers will differ considerably more than $\frac{1}{125}$ inch, it was evidently necessary to provide for holes of different diameters and tapers. This is effected by the adjustable gauge, which takes the exact form of the hole. When it is withdrawn, the exact diameter within $\frac{1}{1000}$ inch at each end can be ascertained and read off on the scale. The turner then has only to turn the pin $\frac{8}{1000}$ inch larger, using the same calipers, and as the calipers are not sprung over the pin, but the touch piece is lightly kept in contact by a small spiral spring, and the size can be plainly read off on a scale, there is no guessing, and no difference can arise from a variation in the force with which the calipers are pressed against the work. It will be noticed that the scale does not give the full dimension, or indeed any positive size, but merely the fractional parts or differences in size, which it is important to know. Thus, on calipering the gauge when it is withdrawn from the crank pin hole, the index finger may stand at 6. It is not necessary to know whether the diameter of the hole is 3·70 inch or 3·80 inch; all the turner has to do is to turn the pin so that the index reads 14 instead of 6. He can then be certain that, whatever the diameter of the hole, the pin is $\frac{8}{1000}$ inch larger, and this is all that is practically required.

Another very useful little contrivance has been in use for some years for readily ascertaining whether the crank pins on an engine are at right angles to one another. It often happens that after the engine has been running some time the axle becomes twisted, and consequently the crank pins are no longer at 90° apart, though originally correctly set in a quartering machine. The little tool (shown in Fig. 1) enables the accuracy of the pins to be tested.



The wheel, being placed with the crank downward, the right angle fork at the lower end of the gauge is put on the crank pin, and the inclined face is brought into a line with the center of the axle. The instrument being clamped to the wheel, the latter is turned until the bubble in the spirit level stands central. It is obvious then that the line joining the centers of the crank pin and axle is inclined at an angle of 45° with the vertical center line of the axle. The instrument is now unclamped and set on the other crank pin. If the bubble in the spirit level again stands central, it is evident that the line joining

the centers of this crank pin and the axle is also at an angle of 45° from the vertical; and that the sum of these angles being 90°, the crank pins are correctly at right angles to one another. If the bubble stands away from the axle, the crank pins are less than 90° apart, and if the angle between them is too great the bubble will stand toward the axle.

Stow's flexible shaft drills are an exceedingly useful and convenient appliance in a locomotive repair shop, and it is somewhat surprising that they are not more generally used. They are usually driven from the main shafting, but Mr. Leroy Bartlett, the master mechanic at St. Louis, has gone a step further and gets the power for truing crank pins, reboring cylinders in place, and drilling any odd holes required by an engine under repairs, by means of small portable three cylinder engines of the Brotherhood type. The engine has three 3½ inch cylinders, and is mounted on wheels so that it can be readily moved about the shop. It is driven by compressed air, furnished by three old Westinghouse air pumps that are past regular service on the road. They deliver into old engine reservoirs from which air mains are laid through the shops. The main pipes have branches provided with globe valves and nozzles to which rubber air hose can be attached. The portable engine being brought near the locomotive under repair, the hose and Stow flexible shaft are coupled up, the air turned on, and the work proceeds. Suitable gearing provided with proper sockets can be used between the engine and flexible shaft, so as to obtain the proper speed. In this way a repair job can be done at night without keeping the stationary engine and main shaft running. The boilers will generally furnish enough steam to keep the pumps going, or the pump of a live engine in the round house can be utilized. This method of obtaining power would appear to be very convenient especially in small remote round houses without any stationary engine or boiler. As at present arranged, when an engine comes in needing some small repair requiring a little turning and drilling a few holes the work must be done by hand, though the boiler of the engine containing 60 or 70 pounds of steam all night would afford ample power for the purpose, could it be properly utilized. The use of a small three cylinder engine, driven by compressed air, appears to be a cheap and convenient method of getting over the difficulty. Of course steam can be used for driving the engine, but its heat, of course, affects the hose, and the condensation and exhaust might be somewhat inconvenient.

A variety of special reamers and cutters are used for standard parts of engines. Thus one set of cutters is made of the proper shape for making the seat of the pop valves, which can thus be very readily trued up, and all remain the same diameter and taper. The mud plugs are also all tapped to the same taper by an attachment to an ordinary turret lathe for brass work. The taper bob on the lathe spindle gives the correct pitch, but the screw cutting arm being unsupported by the shears of the lathe, as in cutting a parallel screw, is apt to spring unless steadied in some way. A small tapered piece is therefore laid down on the shears, and the arm bearing on it is thus supported at both ends and cannot spring. Of course the taper of the hob and the taper of the packing piece on the lathe bed must be arranged to correspond, so that each performs its share of the work.

The wheel press is arranged to put on both wheels simultaneously, thus effecting some saving in time. With this method of working it often happens that when one wheel is pressed up to its place the other has still some distance to go. The annexed diagram (Fig. 2) shows the method in

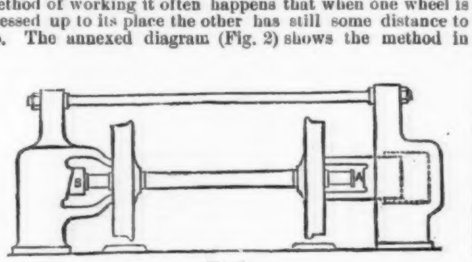


Fig.2

which this difficulty is overcome. If the left hand wheel is pressed up to its place first, the movable wedge, B, can be adjusted to prevent the wheel moving further on the axle, and the hydraulic pressure will then only tend to force the right hand wheel on similarly; should this wheel be on far enough, a liner is placed at A, between the axle and the ram, and then the pressure tends only to force on the left hand wheel. Wheels can thus be put on very rapidly, and with as much accuracy as by the ordinary method of putting on one wheel at a time. When putting on standard wheels and axles, the position of the wedge, B, and the thickness of the liner at A can be adjusted so as to insure the wheels being pressed on almost exactly right every time, a trifling adjustment being requisite occasionally to compensate for roughness in the castings, etc.

The twisted wire for lead car seats is made on a machine which twists the wire and cuts it off to length. About 500 pounds of twisted wire is turned out per month. The lead seats are cast, ten at a time, in a species of bullet mould, the cores of the holes being formed by two long wires running the length of the mould.

The brass foundry flues are kept separate for each crucible until they ultimately deliver into the main vertical chimney. The brickwork of this chimney is supported on an iron girder placed some 6 feet above the floor of the brass foundry, and therefore above the action of any excessive heat. The bricks below the girder can therefore be replaced or repaired without disturbing the chimney above. The furnaces for heating the crucibles are each distinct, and the firebrick lining is contained in a separate cast iron casing for each furnace, the casing standing on cast iron pillars. The air can therefore freely circulate round the casing, and any one furnace can be readily repaired without disturbing its neighbor. The grates are furnished with a shaking arrangement which can be operated from the floor of the foundry, without descending into the ash pit. Cleaning holes are provided for both horizontal and vertical flues. All the car brasses are babbitted, a very necessary precaution, many of the cars having short journals, considerably smaller than the M.C.B. standard.

Substantial cast iron smiths' hearths are made here for the different shops of the company. As these hearths can be very quickly erected and moved whenever some rearrangement of the shop is thought desirable, they present many advantages and occupy less room than a hearth composed wholly of brick, and, if properly proportioned and well lined, are quite as durable, and require fewer repairs during their lifetime. The whole of the main part of the hearth, including slack trough, is made in one casting, the back alone being separate. This makes a very substantial job, there being nothing to get loose.

The air valves for their hearths are also made in the St. Louis shops, a simple brass slide valve kept against its face when shut by the pressure of the air.

The bolts used are all made to standard gauges for diameter and taper, and no measuring diameters of bolts is allowed. An erector orders the bolts he wants by giving length and number, and the men at the bolt lathes are not permitted to go down to the engine and caliper the holes. Sets of cast iron blocks having reamered holes of different sizes to the standard taper are used with male gauges, and a plate with accurately bored holes is kept locked up and used only to test the accuracy of the gauges. The reamers when worn too small for one size are ground down to the next.

The taps are backed off by an eccentric motion, which gives a reciprocating action to the slide rest, withdrawing the tool from the tap as the cutting edge of each groove comes round, the motion being of course geared to correspond with the number of grooves in the tap. Coal oil is used as a lubricant in tapping cast iron, being found better than lard oil.

The driving brasses are forced into the axle boxes by 20 tons hydraulic pressure. A small vertical hydraulic press is used for this and similar work. This is found to be far preferable to the old plan of driving the brasses in with a sledge hammer.

The floor of the machine shop is laid with oak planks nailed to stringers, the whole floor resting on sand rammed down firmly. To judge from the condition of the floor, which is remarkably level and even, and appears to have needed no repairs, this method gives excellent results.

A small jib and a small traveling crane are used in the machine shop for lifting work in and out of the heavier machines, but the engines are still lifted by jacks.

The machine shop is lit by four arc lamps, both lamps and dynamos being made at the works. Mr. Leroy Bartlett, the master mechanic, has carried out an extensive series of experiments on dynamos, and has at length achieved some very satisfactory results.—*Railroad Gazette.*

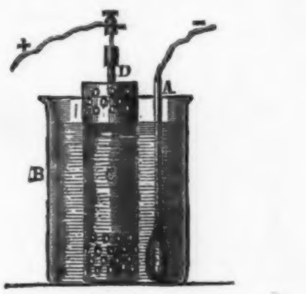
NEW BATTERY WITH AN ALKALINE LIQUID.*

THE alkaline liquid batteries, and especially that of MM. Lalande and Chaperon with oxide of copper have latterly attracted the attention of electricians.

The inventors have undertaken to render their battery as practical as possible, so as to render it fit for industrial and scientific uses.

While admitting the merits of this battery, we are persuaded after prolonged experimentation that the oxide of copper may be advantageously omitted, taking, as the positive pole of the battery retort, carbon broken into small fragments. Although it is not easy to suppose any true chemical action taking place in the carbon, yet experience has shown us that a positive element thus formed is polarized only with great difficulty so that it may be usefully employed in our battery, even when kept for a long time in action with a closed circuit.

The form which seems to us the best for our battery resembles that of the Leclanché element.



The zinc, A (see figure), which must be carefully amalgamated, is immersed in a solution of caustic potash contained in a glass vessel, B.

The positive pole is in the middle, and is formed of a cylindrical vessel, C, of very porous earth, the sides of which are perforated with a large number of holes large enough to let the liquid penetrate without allowing the fragments of carbon contained in the same vessel to escape. In the center is placed a small rod of carbon, D, which serves as an electrode, and for which may, without inconvenience, be substituted a plate or a stout wire of copper.

As soon as our battery is set in action it develops a considerable electromotive force, which may sometimes amount to 1·60 volts, but this electromotive force then decreases very rapidly down to a limit, which depends on resistance of the circuit as compared with the magnitude of the battery. With an external resistance of a few ohms we obtain a permanent action differing very little from 1 volt.

Nevertheless the great power of this battery, as of that of MM. Lalande and Chaperon, depends on the low internal resistance, which renders it possible to obtain very intense currents with relatively feeble electromotive forces. But even in this respect it seems to us advantageous to substitute carbon for the metallic oxides, which have a weaker conductivity.

We are studying, at present, the most practical manner for regenerating the alkaline solution, so as to utilize the products of the decomposition of the zinc (?), and we hope shortly to present to men of science, and to industrialists, a battery convenient and economical, both as regards the first outlay and the working cost and which may be advantageously substituted for the Leclanché battery.

Already, for some time, a battery on our system has been applied to the fire alarm apparatus at the Alighieri Theater at Ravenna; and so far, the instruments attached to this apparatus to give warning of any decline of action in the battery have not indicated any need for setting in action a reserve battery which is always kept ready in the theater.

Finally, we purpose continuing our researches in order to ascertain what is the action of the carbon in our battery. Researches which may possibly lead to the explanation of other phenomena presented by batteries with solid depolarizers, and which may present some scientific interest, since it is certain that, on setting out from the calories corresponding to the formation of the oxide of zinc, and to its combination with potassa, and taking into account the hydrogen set free at the positive pole, we obtain for the electromotive force a quantity of heat strikingly inferior to that which results from the measurement made directly at the battery.

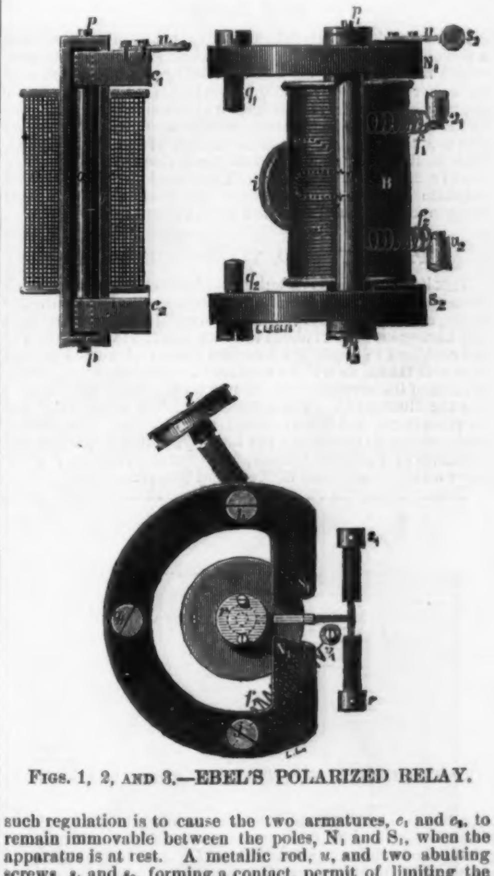
This may, in part, depend on the large surface presented by the small fragments of carbon in proportion to the zinc, but it seems to us that this does not suffice for the complete explanation of the phenomenon.

The absorbing power of the carbon for the oxygen of the air being much superior to that of the hydrogen produced by the chemical action of the potash upon the zinc may, perhaps, contribute to increase the electromotive force of the battery.

* Professors Fabri and Ravaglia in *La Lumière Electrique.*

EBEL'S POLARIZED RELAY.

IN its number for May, 1884, the *Elektrotechnische Zeitschrift* gives a description of a relay for which Mr. J. Ebel took out a patent in England in 1882. The apparatus consists essentially of a bobbin, B, whose core is formed of two pieces of soft iron. The first of these latter is a fixed, hollow cylinder, *r*; and the second is a rod, *a*, movable in the interior of the cylinder, *r*, mounted upon pivots, p_1 and p_2, and terminating in two armatures, c_1 and c_2. Figs. 1 and 2 show an elevation and plan of the apparatus, and Fig. 3 gives a horizontal projection of it. Two permanent magnets, N_1S_1 and N_2S_2, are connected with each other by means of two brass rods, *h* and *j*, and revolve together around the vertical axis of the screws, q_1, and q_2, which serve to fix them upon the base of the apparatus. The columns, *h* and *j*, move in guides in the form of an arc in this same base. Two adjusting screws, f_1 and f_2, which have their points of attachment on the screws, v_1 and v_2, continuously press the two magnets against the regulating screw, *i*. The object of



FIGS. 1, 2, AND 3.—EBEL'S POLARIZED RELAY.

such regulation is to cause the two armatures, c_1 and c_2, to remain immovable between the poles, N_1 and S_1, when the apparatus is at rest. A metallic rod, *u*, and two abutting screws, s_1 and s_2, forming a contact, permit of limiting the travel of the movable cylinder, *a*.

The French Company of the New York and Paris Cable has applied this relay to the Royal Exchange Station, and thinks very well of it. In fact, the electro-magnet is very sensitive on account of the slight weight of the movable parts. The parts, c_1, *a*, c_2, as a whole, weigh but 4·6 grammes. The resistance of the bobbin, B, is 250 U. S.—*La Lumière Electrique.*

ASSAY OF INDIGO.

By CHARLES TENNANT LEE.

THE determination of indigo blue, or indigotin, in indigo presents various difficulties. The processes in use are long, and subject to considerable error. The methods which depend upon the reduction and subsequent measured oxidation of indigo require the elimination, previously, of all other reducible bodies, to insure accuracy—an operation both long and tedious. The method by formation of sulphindigotine, and its estimation by a standardized permanent solution, always gives too high results by reason of the presence of other oxidizable bodies.

For several years the author has used a method by sublimation, which has been uniformly satisfactory. Indigo blue sublimes readily, and, by a careful regulation of temperature, can be separated from the other components of indigo—indigo brown, indigo red, mucilaginous matter, etc.

The operation is best effected in a shallow platinum tray. Those in use are 7 cm. long, 2 cm. wide, 3 to 4 mm. deep. Into such a tray is weighed about 0·25 grm. of finely powdered indigo which has been dried at 100° C. The weighing should be rapid to avoid absorption of moisture, and it is best not to exceed this amount greatly for a tray of the size noted, in order that the layer of indigo may be thin.

Spread the weighed powder evenly over the tray by tapping it with the finger; this can be done easily if the bottom of the tray is quite flat, with no rounding toward the sides. Sublime on an iron plate, at first raising the heat gradually to avoid burning.

When the surface of the indigo is covered over with a shining layer of crystals, turn down upon the plate a piece of Russia iron bent into the form of a flat arch, the highest point of which is about 1 cm. above the plate, and a little longer than the tray. Lower the heat at the same time that the arch is put on, as the temperature rises rapidly.

The purple vapors of indigotin are now given off, a portion condensing upon the under sides of the arch. Raise the heat slowly, and enough to maintain a constant sublimation of indigotin. By raising the arch the progress of the work is seen. For a 50 per cent. indigo the time required is 30 to 40 minutes; but soft, Java indigo must be sublimed with more caution, and sometimes requires two hours. The last crystals of indigotin are easily seen upon the dark colored surface of the residue. When all have disappeared, remove the tray, cool in a disiccator, and weigh. The loss in weight is indigotin. Observe that the heat be no greater than is required to sublime the indigo blue; and that no yellowish vapors appear, which would indicate the destruction of the residue, leaving only ash.

If the bottom of the tray is flat and everywhere touches the plate, the sublimation goes on regularly except in case of very rich indigos, already mentioned, when care must be exercised to prevent burning.

Results by this method are constant within ¼ of 1 per cent., but the author has frequently made redeterminations with variations of only half that error.

A little practice enables one to leave the sublimation with only occasional attention, and three or four determinations may be carried on at once under the same arched cover.

For commercial and industrial purposes this method appears to have dicided advantages. Its rapidity is in great contrast to the other methods, which admit of perhaps two determinations in a day, while in point of accuracy it is not wanting.—*Journal of the American Chemical Society.*

LOSSES OF NITROGEN DURING THE FERMENTATION OF DUNG.

By H. JOULIE.

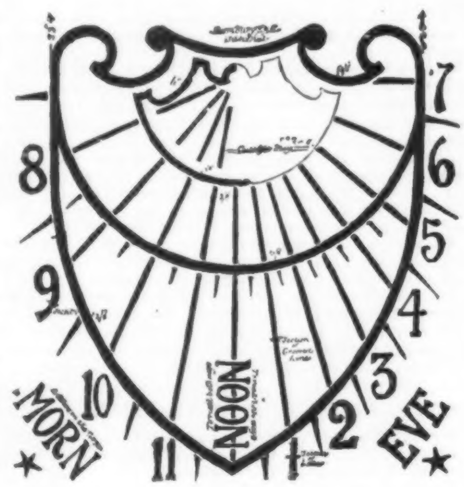
FROM a series of careful experiments the author finds that a prolonged fermentation of dung involves a loss of nitrogen, which reaches 20 per cent. in his trial heaps, but which may be higher in actual practice. This loss is entirely due to the decomposition or the volatilization of the ammonia contained in the urine, and bears consequently upon the most active and the most easily assimilable portion of the dung heaps. The addition of calcium phosphate does not perceptibly modify the extent of the loss. That calcium carbonate and sulphate both largely increase the loss of ammoniacal nitogen, and lessen its fixation upon the organic matter.

PEMBURY END, TUNBRIDGE WELLS.

THE house which is a subject of illustration this week forms, with the stables and other erections and the entrance lodge, a group of buildings just approaching completion on a site having an area of about thirteen acres. It was the aim of the architect to produce a compact plan, and a good deal of care was taken, as will be apparent to architects on examination of the arrangements shown on the plan accompanying the illustration. The appellation given above may not be permanent, but it was found a convenient one during construction as indicating the locality, which is quite on the outskirts of Tunbridge Wells, and near the village of Pembury on the borderland of Kent and Sussex.

The style may be called Jacobean, and the material used is stone, the mullioned windows and copings being of Monk's Park Bath, and the walling generally and a great part of the masonry being of local ferruginous sandstone, got from the deep beds of a quarry in the neighborhood. The remarkable durability of this stone is evinced by a study of the thirteenth-century work of Tunbridge Castle and Bayham Abbey buildings, at the extreme ends of the district. In the latter building, now a ruin, the mouldings are exceedingly delicate, and the arrises still remain quite sharp-edged. The inner part of the walls is built of impervious bricks.

The tower, which becomes important in the view selected, was not part of the original design; but as the site is considerably elevated above its surroundings, and is 500 feet above the sea level, there was a strong desire to command a view of the surrounding panorama. The approach to the summit is by means of an easy circular stair, and the high parapets at



each angle, with their glazed loopholes, serve as wind-guards for those who may like to sit and gaze on the spreading landscapes of Kent on the north and Sussex on the south.

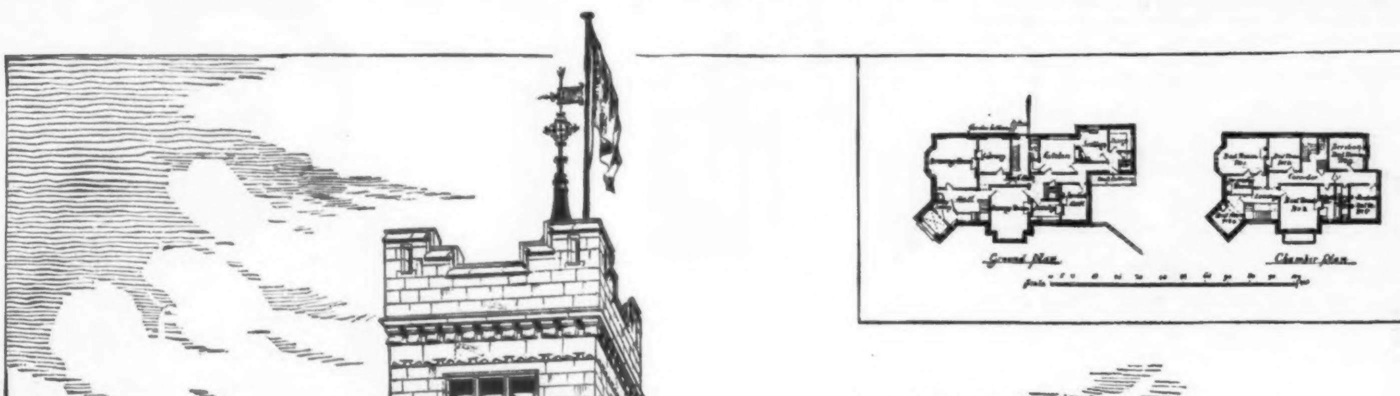
The entrance archway face of the tower is nearly south, and the sun-dial is made to incline toward the west to catch the rays which mark the later hours of the day. The dial with its goomon was calculated and set out by the architect by the use of the terrestrial globe.

The perspective drawing was made by Mr. Thos. Garratt, under Mr. Curzon's directions, and it may be worth while to point out that an experiment in the perspective of the tower has been introduced to meet an inevitable presentment, and, accordingly, in the drawing the tower diminishes upward, which is not the case in reality.—*The Architect.*

THE TECHNICAL EDUCATION INSTITUTE.

THE new buildings in the Exhibition-road, South Kensington, which were opened by the Prince of Wales on the 25th June last, are those of the Central Institution of the "City and Guilds of London Institute for the Advancement of Technical Education." This Central Institution is designed both for a Normal School for training instructors and teachers, and as a kind of University to preside over the different Technical Schools and classes in London and in provincial towns, to direct and reward their studies, and to furnish higher scientific instruction. The aggregate number of students who went up for the technological examinations this year was 3 628, having been 2,322 in the year 1883, and 1,563 the year before. The cost of the new Central Institution exceeds £100,000, in great part supplied by grants from the City Guilds, or Livery Companies, out of their corporate revenues.

The building, which fronts the South Kensington Museum, was designed by a well-known architect, Mr. Alfred Waterhouse, A.R.A. The exterior, 300 feet in length, of a semi-classic character, freely treated, is of red brick with red terra-cotta dressings. It is adorned with the arms of the principal manufacturing towns in the United Kingdom, displayed in relief on its front. In the central gable, over the main entrance, is a Gillett clock striking quarters on three bells, and indicating the hours on a gold mosaic face. The building is, for the most part, five stories in height. In the basement are mechanical workshops, three large ones at the back being top-lighted. The entrance-hall is in the center of the building; and the visitor ascends by a few steps to the great corridor on the ground floor, which stretches from one end of the building to the other. Across the corridor is the main staircase, double arcaded to the top, the piers and balustrades being terra-cotta of a deep golden color. Mechanical class-rooms, physical class-rooms, a museum for industrial apparatus, and a room for the teaching of mathematics, are on these floors. There are also two large lecture-theaters, lighted from the sides, one for chemistry, and the other for physics and mechanics. On the first floor, over the entrance, is a large reading-room and library, with experiment-rooms, and class-rooms. The offices for the administration are at the north end of the building, terminating in the council-chamber, a handsome apartment, on the walls of which it is proposed to emblazon the arms of all the Livery Companies. On the second floor an art-museum occupies the center of the building, with class-rooms and lecture-rooms on each hand. The principal chemical class-rooms are over the large lecture-theaters. On the third floor, above the art-museum, is a large room, 67 ft. by 35 ft., with a fine semi-circular roof, for museum purposes. At one extremity of the building is a lofty refreshment-room, for students and others, with kitchens and larders adjoining. At the opposite end is a large special laboratory, adjacent to the general chemical laboratories, which are over the chemical class-rooms. The entrance-hall and principal corridors have marble mosaic pavements. There are dinner and coal lifts at one end of the building, and a large steam lift for bulky articles at the other. The internal finishings are principally of deal, painted, the fireplaces and chimney-pieces of glazed brick and stone. The heating and ventilating have been intrusted to J. L. Bacon & Co. The ironwork has



SUGGESTIONS IN ARCHITECTURE.—A HOUSE IN THE JACOBEAN STYLE.

been furnished by Messrs. W. H. Lindsay & Co. Mr. Henry Lovatt, of Wolverhampton, was the general contractor for the works.—*Illustrated London News.*

THE CITY AND GUILDS OF LONDON TECHNICAL EDUCATION CENTRAL INSTITUTE, SOUTH KENSINGTON.

EMULSIONS IN GELATINE AND ALBUMEN.

THE process we prefer, says *The British Journal of Photography*, is based on Mr. W. K. Burton's principle, though we have varied it in the details. We have adopted the following formula:

1.	
Gelatine	30 to 50 grains.
Bromide of potassium	300 "
Water	20 ounces.
2.	
Silver nitrate	1 ounce (437·5 grains).
Nitric acid	1 minim.
Water	1½ ounces.
3.	
Iodide of potassium	15 grains.
Water	1 drachm.

The three solutions having been made, we commence their mixture by cautiously adding, drop, by drop the solution of iodide of potassium to the concentrated silver solution, agitating after each addition. The first effect will, of course, be the formation of a precipitate of iodide of silver, but this is rapidly redissolved by the excess of silver nitrate until the solution becomes saturated. Under favorable conditions the full quantity of iodide may be thus added—that is to say, if the silver solution be sufficiently concentrated and its temperature not too high. However, the addition of iodide is continued until a permanent milkiness remains, when the remainder of the iodide, if there be any, is set aside until again required.

The bromized gelatine solution is now raised to boiling-point in the ordinary digester, and the silver added to it in the usual manner, and thoroughly mixed by shaking or stirring. When this is done the remainder of the iodide is added, and the cooking proceeded with by any of the methods in vogue. We prefer for our own part the ordinary boiling process, which is carried on to the verge of the blue stage if an emulsion of moderate rapidity only is required, or further in proportion. Or, after allowing the emulsion to cool, ammonia may be added, and the whole digested at a low temperature for an hour or so.

By the above plan of adding the iodide a very fine state of division is insured as well as a higher degree of sensitiveness. The proportions of silver and haloids are so near the point of neutrality that very little trouble will be experienced in securing a rapid deposition of the sensitive precipitate; but if it should exhibit a reluctance to subside, longer digestion with ammonia or longer boiling, as the case may be, will bring about an improvement. We find that an emulsion made in the evening will have invariably subsided sufficiently by morning to allow of the first change of washing water being made. Three such changes in all will prove ample.

The precipitated bromide having been thoroughly washed is transferred to a suitable flask or bottle; or, preferably, the washing may be performed in one of the conical precipitating or "parting" flasks, obtainable at any chemical glass warehouse. Into this is introduced 200 grains of hard gelatine, such as Heinrich's, previously swelled in distilled water, and sufficient water to make the bulk up to ten or twelve ounces. Heat is applied, and, as the gelatine dissolves, the flask is vigorously shaken to secure the thorough emulsification of the bromide. If, as will probably be the case, the bromide show a tendency to retain a slight granularity, it will be necessary to raise the temperature to about 200° Fahr., or even higher, and to keep it there, with occasional agitation, until the necessary degree of fineness is attained. It is for this reason—the probable necessity for the application of a high temperature—that the albumen is not added until the last stage of the operation.

While the above operations are proceeding, take the whites of the necessary number of eggs and beat them into a stiff froth without the addition of water, ammonia, acetic acid, or any of the ordinary additions. For the above quantities of the ingredients four ounces of liquid albumen will suffice, or, roughly, the whites of four eggs. These having been converted into froth of such consistency that the vessel containing it may be reversed without any loss of albumen, the latter is transferred to a clean funnel of sufficient size, placed in a bottle or other vessel to catch the albumen as it gradually reliquefies, which it will do in the course of a few hours.

Returning to the emulsion, which we will now suppose to have gained the requisite degree of fineness; it is allowed to cool down to 90° or 100°, when the albumen is poured into it, and thoroughly mixed. All that now remains is to make the bulk up to twenty or twenty-four ounces (according to taste), to filter, and the emulsion is ready for coating.

Emulsion made in this manner sets rather more slowly than usual, owing to the smaller proportion of gelatine it contains, but dries rapidly to a hard, glassy film. The films appear thinner and more transparent especially when dry than ordinary ones, but show no deficiency in the matter of density. Should still greater hardness be required, if the plates are to be long kept or subjected to the vicissitudes of travel, they may be passed singly, after drying, through a dish of good methylated alcohol carefully filtered. This will coagulate the albumen, and though it gives a little extra trouble the return is worth the outlay.

Such plates are moderately sensitive, giving, with half an hour to three-quarters' boiling, fifteen on the sensitometer. They develop quickly, owing, no doubt, to the comparatively porous character given to the film under the action of the alkaline developer. The ammonia, indeed, seems to penetrate instantly, by its solvent action on the albumen, to the very glass itself.

Other methods of precipitation, such as Abney's, may be adopted if preferred, or the late Dr. Monckhoven's carbonate of silver and hydrobromic acid process may be employed, provided the albumen is not added until the bromide of silver has been fully formed. But the plan we have described in detail seems to be the simplest.

The hardness of such films appears to offer a fair prospect of their possessing better keeping qualities than some of the plates of which we have heard recent complaints; and if no impediment in the way of reduced sensitiveness should intervene, we shall expect to see albumen films much employed in the future.

VERMILION MANUFACTURE.

THE following article is taken from Mr. Christy's translation of a brochure on the Imperial Quicksilver Works, at Idria, Krain:

In the oldest times of the existence of the present works, vermilion was manufactured. In the beginning it was merely pure, pulverized cinnabar ore, then later it was a product made by sublimation from this substance; and there were formerly other works for vermilion manufacture than those for quicksilver production. When the Venetians and Dutch began to produce better wares, the production here sank steadily.

The researches of Christofoletti, 1681, and of Baron Richtenfels, 1726, for the improvement of Idrian vermilion, met with as little success as those of some Venetian women—1740–1741—who had lost their husbands in the Venetian works and had offered themselves to manufacture vermilion according to the Venetian method.

After Hacquet had strongly urged the manufacture of vermilion, Oberhuttenmeister Ignaz v. Passetzky succeeded, with the Dutchman Gussig assisting him, in making beautiful cake cinnabar in 1782, and in 1785 vermilion also, in the newly built works on the right bank of the Idriza.

In 1796 Oberhuttenverwalter (manager of the works) Leopold v. Passetzky introduced the sublimate and precipitate manufacture, but it was abandoned as unprofitable in 1824.

The many foreign attempts to manufacture vermilion in the wet way caused similar ones here, as those of Fabriks-Controlor Rabitsch in 1838, and later of Huttenverwalter M. Glowacki, which brought large amounts of the vermilion so manufactured into the market. Still this manufacture came to no full development, and became forgotten, until, finally, in the years 1877 and 1878, experiments led to its being discontinued on account of its costliness and uncertainty of the method. A new set of experiments in 1878 and 1879, by Assayer E. Teuber and Director of Works (Huttenverwalter) H. Langer, under the direction of the Imp. Agricultural Ministry, led to favorable results. A new manufactory, set in operation in 1880, furnishes three sorts of vermilion manufactured in the wet way.

The arrangements of the works for the manufacture of vermilion in the dry way consist of: One sulphur stamp battery. One amalgamating plant with eighteen small barrels, both pieces of apparatus being driven by a two horse-power water wheel. Four sublimation furnaces each with six retorts of cast iron. Four vermilion mills, each driven by a water wheel of 2·5 horse power. Kettles and vats for heating, digesting, and refining the ground cinnabar. One drying hearth. The preparation of vermilion, as an article of commerce, falls into several separate operations, viz.:

1. Amalgamation; *i. e.*, preparation of the raw mohr.
2. Sublimation; *i. e.*, preparation of the cake cinnabar.
3. Grinding of the cake cinnabar, refining and drying of the vermilion.

For the preparation of the raw mohr for each charge of eighteen kegs there are taken 80·64 kg. powdered and sifted sulphur, and 423·36 kg. of quicksilver.

The amalgamating kegs each contain twenty-eight kg. of the charge, and are given intermittent rotating motion by a rack and pinion driven by a water wheel. After an average of two and three-quarter hours, the amalgamation is complete, and the raw mohr is taken from the casks.

For the sublimation four furnaces are used, each with six pear-shaped cast iron retorts of considerable thickness. Each is charged with fifty-eight kg. of mohr, the mouth covered with a loosely placed sheet iron helmet, the furnace being slowly fired; the combination of the sulphur and the quicksilver then results in about fifteen minutes, with a detonation. As soon as this operation (das Abdampfen) is over, a clay helmet is placed over the retort, and the firing is increased, so that after two hours and twenty minutes the excess of sulphur evaporates from the tube. The condenser is now added (Stuckperiode—Cake-period) and luted, then the firing is still more urged, whereupon the cinnabar volatilizes and deposits itself upon the glazed earthenware condensation apparatus (tube, helmet, etc). After four hours, the sublimation is complete, and there is furnished by the helmet 69 per cent., by the tubes 26 per cent., by the condenser (Vorlage) 2 per cent. cinnabar.

The grinding of the cake cinnabar takes place in four mills driven by an undershot water wheel. These mills have a fixed under and upper movable stone, and the grinding is done with water. The vermilion which leaves the spout and runs into glazed clay vessels has a temperature of about 38° C., that of the air being 15° C. The millstones make forty revolutions per minute, and after each passage of the charge are placed nearer together. There are three sorts of vermilion manufactured:

H. R., high red vermilion. D. R., dark red vermilion. C., Chinese vermilion.

From the mill the cinnabar undergoes the refining, which consists in digesting the cinnabar in potash lye.

As soon as the cinnabar charge has settled in the refining vat, the solution is drawn off and the cinnabar is washed with water until the water runs off perfectly clear. The pulpy mass is placed in glazed drying vessels and dried.

The dry vermilion is then sifted and packed.

The greater part by far of the vermilion, as well as cake cinnabar, is packed in tanned sheepskin in packages of 12·5 kg., of which a pair are placed in a wooden keg. Only a small part of the vermilion comes in boxes of 0·5 kg., which again are packed in larger boxes of twenty-five and fifty kg.

SULPHUR: ITS OCCURRENCE AND EXTRACTION.

By C. G. WARNFORD LOCK.

THE following notes relate exclusively to native sulphur (brimstone). Though the amount of sulphur annually mined in the form of sulphides of various metals (*e. g.*, iron and copper pyrites, galena, blende, etc.) probably far exceeds that obtained in the uncombined state, still the separation of the sulphur in an inoxidized condition from such compounds is never attempted, for the simple reason that, in the processes for extracting the several metals from their ores, the first step necessary is the elimination of the combined sulphur, which is most easily effected by a roasting or oxidizing operation, whereby the sulphur is at once converted into sulphurous acid, itself a valuable commodity, and, moreover, capable of being readily oxidized one step further to form sulphuric acid, the chief purpose for which sulphur if consumed.

OCCURRENCE.

It will be most convenient to discuss the occurrence of sulphur deposits under geographical headings, leaving geological differences to be noted as they are met with.

Austro-Hungary.—There are two mines of sulphur worked in this empire, one not far from Cracow, and the other at Radoboi in Croatia; both deposits are of considerable extent, but the annual yield is insignificant. The whole district around Mount Büdös, in Transylvania, is rich in sulphur. The deposits are situated at the south and west of the mountain, the principal localities being Kis Soosmező, Vontala feje Bálványos, and a little above the châlet Gál András; some thirty or more diggings have been undertaken in a circuit of 18 miles, but the area covered by the deposits is more than three times this size. The sulphur occurs in unequal strata 1 to 9 inches thick, beneath 1 to 3 feet of mould. The soil is everywhere saturated with sulphur, and in this permeated earth pieces of the pure mineral are found. The whole is the result of living solfataric action, and the accumulation will continue to grow as long as that action survives. Samples of the impregnated earth, taken over an area of 16,000,000 square fathoms, yielded from 41 to 64 per cent. of sulphur. Allowing for interruptions in the deposits, and taking these at an average thickness of 3 inches instead of 9, Boner estimates that 200 pounds of sulphur might be obtained from each square fathom, assuming 50 per cent. of sulphur in the deposit; continuing the calculation, he thinks the district should afford over 700,000 tons. He reckons the probable cost, at £10 per ton, including carriage from Büdös to Kronstadt; this, he says, is less than the prices paid in the places where it is produced in Poland, Slavonia, and Bohemia.

The total sulphur output of the Austrian empire, in 1863, was 1,754 tons, at an average rate of £12 15 s. per ton. The imports are about 5,000 tons per annum.

Banda Islands.—Large quantities of sulphur are found in and about the crater of Gunong Api, and attempts have been made to collect it for exportation. It is said, however, that the labor of ascending the mountain is too great to render the speculation profitable.

China.—Sulphur is one of the most important products of Formosa. When taken from the mine, the ore is boiled in iron pans till it assumes a treacly consistence. This is constantly stirred till every impurity is separated from the sulphur, which is then ladled out into wooden tubs shaped like sugar loaves. In these it is left to cool, and the conical cakes are freed from the tubs by the simple process of knocking out the bottoms of the latter.

Sulphur is procurable in salable quantities from the mountains around Ta-Chien-la, in Western China; the inhabitants of the ravines may often be seen engaged in the manufacture of matches of the Guy Fawkes pattern, which they split from a pine plank, with a spokeshave, and tip with sulphur. During his penniless residence at Na-erh-pa, Baber generally used these sulphur chips to procure a flame.

France.—Near the hamlet of Tappets, about 3 miles northeast of Apt, in the department of Vaucluse, is a bed of sulphur ore yielding about 20 to 25 per cent. It consists of a sulphur-impregnated marly limestone, and accompanies the lignite beds of the Tertiary system. The deposit is neither very extensive nor very thick.

Iceland.—The sulphur deposits of Krisuvik, in the south of Iceland, were the subject of a paper by C. W. Vincent, published in the *Journal* of Jan. 17, 1873 (No. 1,052, vol. xxi., pp. 137–144); and those situated in the north of the island were described by me in the *Journal* for April 30, 1880 (No. 1,432, vol. xxviii., pp. 508–9). The interested reader may refer to these for details; it will suffice here to give a general idea of the deposits as a whole. They belong to the recent solfataric group, and, though often compared with the Sicilian mines, bear very little analogy to them. The sulphur occurs in a fine state, intimately associated with earthy impurities, as a superficial layer of no great depth, but having recuperative powers that render them practically inexhaustible. They are now the property of an English company, and give promise of being worked to advantage in the future.

India.—The sulphur deposits of India, according to Professor V. Ball,* are unimportant and inconveniently situated. Near a village called Sura-Sany-Yanam, between the mouths of the Godaveri in Madras, small heaps of sulphur are occasionally collected in the dried-up margin of a tidal swamp, where the mineral appears to result from a deoxidation of gypsum by contact with organic matter. Another trifling deposit is reported to occur at Ghizri Bandar, near Karachi. A considerable mine, worked by adits and chambers, exists at Sunnee in Cutchi, Balochistan, and affords the chief supply for Candahar; petroleum is said to be mixed with the refuse of the workings to produce an inferior quality of sulphur, while the pure sulphur is boiled in oil to prepare it in the form of commercial brimstone. This practice recalls the method adopted in Iceland about three hundred years ago, when the crude ore was boiled in train oil, to effect separation of the dross

Sulphur is obtained in some abundance from near a hot spring called Pir Zinda, in the Soree Pass of the Suleiman Hills, Afghanistan. The native Kusranis and Bozdars treat the crude ore, consisting of amorphous gypsum traversed by streaks of sulphur, by distilling it in a retort improvised out of two gharas, one on the fire and the other inverted as a condenser. A "vast quantity" of sulphur is said to occur at Hazara, North Afghanistan. On the southern flanks of the Gunjully Hills, in the Kohat district of the Punjab, a large amount of sulphur is constantly being deposited as a result of the decomposition of pyritiferous alum shales. As much as 1,000 tons a year are said to have been gathered.

At Luni-ki-Kussi, on the west side of the Indus, sulphur is obtained by roasting the loose earth.

The sulphur mines at Nakband (Kushalgarh), on the Indus, 8 miles from the mouth of the Kohat, are 30 to 40 feet deep, and have yielded largely, the ore being sublimed as in Balochistan.

Other localities mentioned as affording sulphur in the Punjab are Gumbat and near Panoba, 4 miles from Shadipur, on the Indus; Jaba, 14 miles from Kalabagh, in the Bannu distaict, and Jeura, near Simla. None of these seem to possess any industrial importance.

The sulphur at Puga, in Kashmir, occurs massive, and as a lining in the clefts and fissures of a sort of quartz schist, often accompanied by gypsum. The process of formation seems to be still at work, judging by hot springs in the neighborhood. The deposits are worked by pits about 8 feet deep, and adits of the same length; but the production is small. A trifling quantity of sulphur is deposited by hot springs in the beds of the Ramgunga and Garjia rivers, in the Kumaun district of the northwest provinces; and a considerable amount is found in the galleries of the lead mines at Meywar, on the Tons River, in the Jaunsar district. Little is known of the Nepalese sulphur mines. In Upper Burma the chief localities are Mooda Myo, Tsein Goon, Kyoukhoo, Bawyine, Dybayen Myo, Pagan Myo, Toogthoo Einlay, and Bhamo district. The dormant volcano of Barren Island affords small quantities of sulphur, the result of solfataric action.

Italy.—The sulphur deposits of the Romagna are situated in the Miocene lacustrine formation, and lie amid the sub-Apennine hills. The mines worked in the province of Forli, by the Cesna Sulphur Company, cover an area of about 260 square kilometers. Their average annual production for the seven years, 1873–79, was 27,780 tons. The cost of extraction, refining, and royalties comes to about £4 per ton, according to Consul Colnaghi. The mineral is worked by blasting, each miner having to bore three holes in six hours, when all are fired simultaneously. At Pergola, some 60 kilometers distant from Ancona, is a sulphur mine worked by a German company, which shipped 90 tons of refined sulphur to England in 1880. In Central Italy, near Bologna, a vein is worked which extends over 15 miles in length. The ore is poor, and has to be raised from a considerable depth.

Japan.—Sulphur is said to be abundant in the island of Yezo.

Philippines.—A good deal of sulphur is collected at Camiguin.

Sicily.—Some notes on the sulphur mines of Sicily have appeared in the *Journal* (see Feb. 17, 1882). They may be supplemented by the following:

At the end of the middle Miocene period, the sulphur bearing area was raised, and lakes were formed in which occurred the deposition of the sulphur rock and its accompanying gypsum, tripoli, and silicious limestone. The sulphur rock is composed of sulphur and marly limestone, the sulphur being sometimes disseminated through the limestone, and at others forming thin alternate layers with it. These sulphur-bearing seams are often separated by layers of black marl, 20 inches to 6 feet thick, some seams attaining a thickness of 28 feet. The total aggregate thickness of the sulphur seams reaches 100 feet in one case, but the average total is 10 to 12 feet only. All the seams are decomposed at their outcrop, and show only an accumulation of whitish, friable earth, called *briscale* by the miners, and mainly composed of gypsum. This has resulted from the oxidation of the sulphur to sulphuric acid by atmospheric agency, the acid in turn attacking the lime carbonate, and forming sulphate (gypsum). The most plausible supposition as to the origin of the sulphur seams would appear to be that the lakes received streams of water containing calcium sulphide in solution, this calcium sulphide probably resulting from a reduction of the masses of calcium sulphate (gypsum) by the action of volcanic heat. Gradual decomposition of the calcium sulphide in the presence of water would finally result in a deposition of sulphur and of lime carbonate, in the relative proportions of 24 to 76 per cent. As a matter of fact, much of the Sicilian ore actually has this percentage composition. Whatever the process has been, it is no longer in activity, and there is no growth nor renewal of the beds, in this respect differing essentially from recent deposits due to "living" solfataric action.

Almost all the Sicilian ore is carried to the surface on boys' backs, consequently it does not pay to work below about 400 feet, as it then becomes necessary to employ hauling machinery. Hence the deposits lying below that horizon are hardly touched, and as many of the beds are nearly vertical, and do not diminish in yield as they descend, the still untouched resources must be very great. Various estimates have been made as to the period for which the supply will last at the present rate of consumption; these range from fifty to two hundred years. There are said to be about 250 mines in the island, and no less than 4,367 *calcaroni* were reported in operation fifteen years ago. The average yield is stated not to exceed 14 per cent.

Spain.—In the province of Murcia and at other places the existence of fine beds of sulphur has been ascertained. One is worked by an English association, the Hellin Sulphur Company. The quality is very good.

Suez.—A sulphur deposit exists at Djemsa, in a perfectly rainless desert on the African coast, very near the sea, and constituting a hill 600 feet high, whose sides are blasted down as in quarrying stone. Some two hundred Arabs, employed under French engineers, succeeded in mining 10 tons a day. A similar deposit occurs at Ranga, 500 miles from Suez, also near the coast of the African continent, which differs only in being buried under other strata, so that mining is necessary.

Sunda Islands.—The Gunong Jollo, or sulphur mountain, lies southwest of the village Prado, and southeast of Dompo. The sulphur is dug from three places in an old crater now in the solfataric stage of its existence. Each spot is 100 to 120 roods long, and 50 to 60 broad. The sulphur collects between masses of white stone (perhaps decomposed trachyte), and sometimes covers a space of 1 to 3 roods square. On the liquid and warm sulphur a hard crust forms 2 inches thick. Digging is only carried on at morning and evening, the heat being too great at mid-day. Round holes are made, 8 to 9 feet apart, 2 feet deep, and with an outlet from above of 1 foot, and from below of 3 or 4 feet. Sulphur is also found in the solfatara of Gunong Prewa, but in trifling quantity. A great deal exists on the sides of Tambora.

Tripoli possesses a sulphur deposit important both for extent and richness, but it is not worked.

Turkey.—Native sulphur is found in some quantity adjacent to the lead lodes at Devrent (Derbend), near Alashehr, Salykiœ, and Nymphi. A sulphur mine exists two days' ride from Arta, and four from Butrinto, Albania. Some Italians are said to have secured a concession of a "basalt vein containing sulphur" near the Dardanelles. This has a very doubtful look, and if the mine alluded to be the same as the one examined in 1873, the formation is the exact counterpart of that met with in Sicily, and the neighboring basalt has nothing to do with the sulphur. This mine exists at a place known as Komarla, and the mineral affords about 40 per cent. of sulphur. A similar mine occurs at Alahtan, about six hours from Kassaba.

United States.—Sulphur is found native in Nevada, California, Utah, Virginia, Louisiana, and other States, occurring in beds of considerable bulk in Uintah County, Wyoming, near Evanstown, where it is said to be quite pure; also in some quantity in the Yellowstone Park, Montana and in various localities in New Mexico. It is only worked to any extent in Nevada and California, and even there not on a large scale, the total production in 1880 being stated at under 600 tons. Locally produced sulphur cannot compete in price with imported Sicilian, on account of the cost of land transport; it is, moreover, found to be often contaminated with arsenic, which greatly reduces its market value and limits its application. At the most important mine, called the Rabbit Hole, in Humboldt County, Nevada, the sulphur occurs as an impregnation in a white volcanic tuff or breccia, of Miocene age. The deposit is worked by regular mining, and the mineral, containing 15 to 40 per cent. of sulphur, is dealt with by the steam process, the production being sometimes six tons a day. At the Pluton mines, California, the sulphur is found as a crystalline body scattered through a confused mass of decomposed rocks, and intimately associated with cinnabar, apparently occupying an ancient crater. The mineral is removed altogether, and the sulphur is either recovered by steam process, or, if both sulphur and cinnabar are in paying quantities, the mass is put into a mercury distilling furnace, and the sulphur is separated from the mercury by passing superheated steam into a chamber situated in front of the mercury-condensing chamber.

EXTRACTION.

Sulphur is extracted from the earthy materials with which it is intimately associated in nature, by the following several means: (1) Dry heat (roasting the ore in mass); (2) wet heat (melting out by the aid of aqueous solutions of salts, the salts being added to heighten the boiling point); (3) superheated steam; (4) chemical solvents. The great bulk of all the sulphur produced is extracted by apparatus belonging to the first class, and including the *calcarelle*, *calcarone*, and *doppione*.

Calcarelle.—The earliest system adopted in Sicily was the *calcarelle*. This consisted simply of a stack of ore, 6 to 15 feet square, built in a ditch 3 or 4 inches deep, and whose floor was beaten hard and sloped to a single point, permitting the molten sulphur to flow out by an opening termed the *morto*. In building the stack, care was taken to put the largest pieces of ore at the bottom, selecting lumps of gradually diminishing size as the top was approached. The mass was ignited at the summit. The construction of the stack usually occupied two days; on the third day the sulphur escaped by the *morto*, and on the fourth the *calcarelle* was pulled down. The air necessary for the combustion of a portion of the sulphur (to afford the heat required to smelt the remainder) was freely admitted at all sides; only the mineral in the center of the heap was heated without actual contact with the air, so that its sulphur was melted out instead of being burned (oxidized). Consequently about 6,700 lb. of sulphur mineral were needed to afford 385 lb. of sulphur, or a yield of 5·7 per cent.; as the ore contained 35 per cent. of sulphur, the consumption of sulphur as fuel was 1,960 lb., in order to extract 385 lb. In addition, the immense volumes of sulphurous acid emitted from the stack caused a terrible destruction of the agricultural crops in the neighborhood.

Calcarone.—Nearly all the sulphur prepared in Sicily is now extracted by the *calcarone*, (or *calcherone* as it may also be spelled). This, as is shown in the Figs. 1 and 2, is formed by building a circular stone wall on an inclined sole. In front is the *morto* or outlet, having a height of 4 to 6 feet, and a width of 2 feet; over it is erected a wooden shelter for the workman in charge. *Calcaroni* may contain from 200 to 400 *casse* (each *casse* being equivalent to about 6 tons, and giving 12 to 16 cwt. of sulphur). The durability of the *calcarone* is governed by the care exercised in its construction; ten years is not an unusual period. The charging of the *calcarone* is a matter of primary importance, as on it depends the yield of sulphur. The largest pieces of ore are selected for the first layer, leaving interstices between them; the size of the lumps gradually diminishes as the height increases, care being taken to form the walls of the *morto* with calcareous stones, so as to insure a passage being maintained for the escape of the liquefied sulphur. In adding the finest portions on the top, narrow channels, about two feet apart, are left for the draught to carry the heat down. The whole is covered with a layer of the refuse from previous operations. This layer is more or less thick, according to the state of the weather, because the *calcarone* being built in the open air, variations of temperature and wind influence the progress of the operation; consequently means have to be adopted to prevent an undue access of air rendering the combustion too rapid. For instance, during a sirocco (local hot wind) there is danger of the sulphur contained in the ore lying at the side facing the wind being completely converted into sulphurous acid, and thus lost. The employment of a roofed shed would prevent much of the waste occasioned by climatic causes.

When the charging is completed, the *morto* is closed by a stone slab, and fire is communicated to the mass by means of little bunches of dried herbs, dipped in sulphur, which are thrust into the vertical channels before mentioned. Some six or eight days afterward, a hole is pierced in the top of the *morto*, by means of an iron rod; later, a second hole is made near the floor. By these two openings the sulphur escapes, and is collected in wooden buckets (*gravite*), shaped like a truncated cone, and holding about one hundredweight of sulphur. These buckets cost over 2s., and serve only for three or four castings without wanting repairs. The outflow of sulphur lasts for a fortnight or a month. Commonly, the *calcarone* is left to itself when once the mass has been ignited, but then the loss of sulphur is much more serious. To insure good results many precautions have to be observed, mainly connected with the nice adjustment of the draught, so as to effect the maximum degree of fusion with a minimum of oxidation. When the operation is conducted during winter, the product is less

* "Economic Geology of India."

abundant, and of inferior quality. After the charge is exhausted, a new one cannot be introduced till the mass has cooled down, occupying a period of ten days to a month, according to the size of the *calcarone*. The discharging has to be done slowly and cautiously, on account of the sulphurous fumes liberated. The consumption of sulphur (as fuel) in the heating is about 50 per cent. of the total amount contained in the ore. Thus, to obtain one ton of sulphur, there is consumed as fuel about another ton, worth, say, £5, and performing a duty which could be much more satisfactorily accomplished by two hundredweight of coal, costing, perhaps, 5s.

Calcarone, Foster's Improved.—A great improvement in the Sicilian *calcarone* has been introduced by P. Le Neve Foster, and worked with good results, showing an increase of yield of 30 per cent. above the ordinary plan. According to his description, the waste heat from an ordinary *calcarone*, after all the sulphur has been run off, is utilized to heat to the required temperature the charge of ore placed in his kiln, and as soon as the moisture has been driven off and the heat is great enough, the charge is fired from the top. The combustion, fed with hot air containing some sulphurous acid gas, is very slow, hence the loss of sulphur by burning is less than when, as in the ordinary *calcarone*, the ore has to be heated entirely by the combustion of the sulphur. The apparatus (shown in Fig. 3,* prepared from a drawing kindly furnished me by the inventor) consists essentially of three parts: (1) the flue, or conductor of heat;

FIG. 1.

(2) the kiln, in which the ore is treated; (3) the chamber for the condensation of the sulphur that is volatilized during the fusion, and in which it is collected.

The kiln may be of any suitable form to contain two charges of ore, but a rectangular chamber is found to be most convenient, with floor sloping toward the front. The chamber consists of four walls, preferably not covered with an arch, as affording greater facility for charging and discharging. The kiln communicates, by means of a flue, A, with the back of an ordinary *calcarone*, B, which furnishes the heat necessary for melting the sulphur from the ore contained in the kiln, C. The upper portion of the *calcarone* should be covered with a layer of *genese* (spent ore), so as to prevent the dispersion of heat by any other channel than that offered by the flue, A, which is provided with a damper, D, so as to regulate of heated air by openings, E, at the upper back part of the kiln. A rectangular opening, F, is left in the front wall of the kiln, from which the melted sulphur is run. This opening, if of sufficient size, may serve for discharging the spent ore at the termination of the fusion. From the upper part of the opening, and also in the front wall, slightly above the level of the floor, flues, G, communicate with a horizontal passage, H, which is made large enough to serve as a condensation chamber, on the walls of which the sublimed sulphur collects. At one end of the chamber is a vertical chimney, I, provided with a damper, K.

The kiln is charged in the usual way by placing the large pieces of ore on the floor in such a manner as to leave passages for the flow of the liquid sulphur; the small pieces are next filled in, and the finer ore at the top. A few blocks of rough stone, or burnt ore, are placed at the opening in front in such a way as to leave a vacant place for the melted sulphur to collect before being run off. When charged, the ore is covered with bricks laid flat, and on these is put a layer of *genese*, well rammed and wetted, so as to form a nearly impermeable coating, with a slight slope toward the walls, in order that the rain water may run off. The opening, F, in the front wall should be closed with a thin wall of plaster of Paris. The ore in the kiln, which is now read for fusion, is put in communication with the spent *calcarone*, B, by opening the damper, D, and at the same time a small hole, N, is made in the wall that closes the opening in front, from which the melted sulphur has been run off from the *calcarone*, B. The current of air entering by the hole, N, and passing through the incandescent mass of ore, is thus heated, and enters enters the kiln by the flue, N, at a sufficient temperature. In this manner the heated mass of spent ore in the *calcarone* becomes a regenerator of heat, to be utilized in the

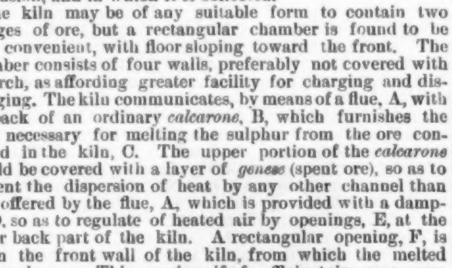


FIG. 2.

kiln for the fusion of the sulphur that it contains. In the upper covering, two or more tubes, O P, are placed, and serve not only for observing the internal temperature by a thermometer, but also for firing the mass.

The combustion of the sulphur supplied with hot air, mixed with a considerable proportion of sulphurous acid gas, proceeds slowly in the upper part of the kiln, and the liquid sulphur dropping to the floor, over the already heated ore, cannot solidify and choke the passages, and so prevent the circulation of the heated air and products of combustion of the sulphur to the chimney; in this manner the operation proceeds with regularity. The success of the kiln is principally due to the manner in which it is heated from the top and back toward the front and bottom, imitating to a certain degree the manner in which the heating of an ordinary *calcarone* proceeds, with this difference, that the heat is better utilized in the kiln, and, therefore, with less consumption of sulphur as fuel.

When the wall that closes the front opening, F, begins to heat, and the kiln is ready for running, a small hole is made with a pointed instrument, so as to allow the melted sulphur to flow off into wooden moulds. The horizontal flue or condensing chamber, H, should have a sloping floor, and when the temperature in it reaches the melting point of sulphur the flowers that have been deposited on the sides are liquefied, and run off. Toward the end of the operation it will be found prudent to close all the dampers as well as the hole, N, to prevent the overheating of the kiln, in which case the sulphur would become thick, and difficult to run off, and the yield would consequently be lessened.

The first cost of the structure is slight, as the materials necessary are usually at hand. The yield too is much increased; but on the other hand the extra cost in charging, discharging, and attendance, as compared with the ordinary *calcarone*, make a large hole in the increased returns.

Doppione.—It will require little reflection to see that only a small quantity of the finely pulverized mineral, necessarily produced in the operations of mining and breaking down the ore, could be dealt with in the *calcarone;* consequently for a long time the bulk of this portion of the ore was simply thrown away, though it often assayed 70 per cent. of sulphur. The *doppione* was one of the earliest successful structures designed to remedy this state of things. As shown in Fig. 4, it consists of a set (generally six) of cast-iron pots, holding about 30 to 40 gallons each, arranged in a gallery furnace, *e*, so as to be completely enveloped by the heated vapors from a fire beneath. Each pot, *a*, communicates

FIG. 3.

by a long arm, *b*, with a cooling condenser, *c*, for the distilled sulphur, placed outside the furnace. The apparatus is generally employed on rich material, or on that obtained from the *calcaroni;* but it is also applicable to ores which are too poor to burn in the *calcaroni*, though the profit in that case must be small. The heat generated in the *doppione* is likely to encourage chemical action between the sulphur and any lime carbonate that may chance to be present in the mineral, creating a further loss of sulphur. The pots are charged and discharged by opening the lids, which are kept luted during the distillation. The volatilized sulphur is conducted by the cast-iron tube, *b*, into the receptacle, *c*, over which a small current of cold water constantly flows, reducing the sulphur to a fluid condition; it then escapes into the dish, *d*, beneath, whence it can be ladled into the moulds. The pots last for about 300 working days, and the furnace serves about the same time with a couple of repairings. The workman is expected to turn out 100 lb. of clean sulphur from every 109 lb. of *calcarone* sulphur.

Calcium chloride.—The principle underlying the use of calcium chloride is that, while raising the boiling point of water to about 239° F. (115° C.), the melting point of sulphur, it is cheap and inert in the presence of sulphur. The water to be used in the melting process is charged with 66 per cent. of the calcium chloride, and heated to boiling, in which state it is run into the vessel containing the sulphur to be melted. No doubt the sulphur is efficiently melted, but the very slight difference in specific gravity between the sulphur and the associated impurities from which it had been melted out practically precludes any real separation taking place. Consequently the process is virtually a failure, as I am assured by those who have worked it.

Steam.—At the Rabbit Hole mines, Humboldt County, Nevada, advantage is taken of the liquidity of sulphur at 232° F. (111° C.) to use steam at 60 to 70 lb. pressure for melting the sulphur out of the gangue. The apparatus employed consists of a cylindrical iron vessel, about 10½ ft. high, divided into an upper and lower compartment, by means of a horizontal sheet iron diaphragm perforated with ¼ in. holes. As soon as the upper compartment is charged with ore (about 2 tons), steam is introduced for about half an hour, and the sulphur, liquefied by the heat, flows down through the diaphragm into the lower compartment, kept at the proper heat by injection of steam, and escapes by an outlet, opened at intervals into a receptacle placed outside. When water commences to flow out with the sulphur, steam

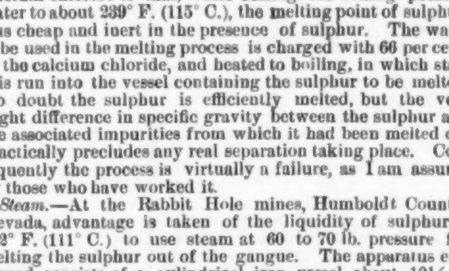


FIG. 4.

is injected at full pressure for a few minutes, to clear out as much as will come, and the solid residue is afterward removed through a door above the diaphragm. Each charge requires about three hours for its treatment. The process is adapted to ores which, for poverty and other reasons, cannot be economically worked by *calcaroni* or other recognized methods.

Carbon Bisulphide.—While hot water and steam have no solvent action upon sulphur, but merely change it from a solid to a liquid state by the action of their heat, carbon bisulphide actually dissolves the sulphur and redeposits it by evaporation. The plant necessary for carrying out this process is shown in Fig. 5. It is designed of dimensions suitable for dealing with 20 tons of raw sulphur mineral per diem, yielding 50 per cent. of pure sulphur. The four extracting pans, *a*, *b*, *c*, *d*, have each a capacity of 5 tons, and are made of ⅜ in. wrought iron plate; they measure 6 ft. long, 4 ft. wide, and 4 ft. deep internally; and are fitted with a perforated bottom diaphragm, with connecting pipes, *m*, leading to the underground solution tank, *f*, with another set of pipes, *k*, for admitting steam from the boiler, *i*, and with a third set of pipes, *l*, communicating with the store tank, *g*. The still, *e*, is a steam jacketed "wrought jacket" pan, 6 ft. long, 4 ft. wide, and 4 ft. deep, with cast-iron ("loam casting") oval-shaped bottom and ends, ½ in. thick,

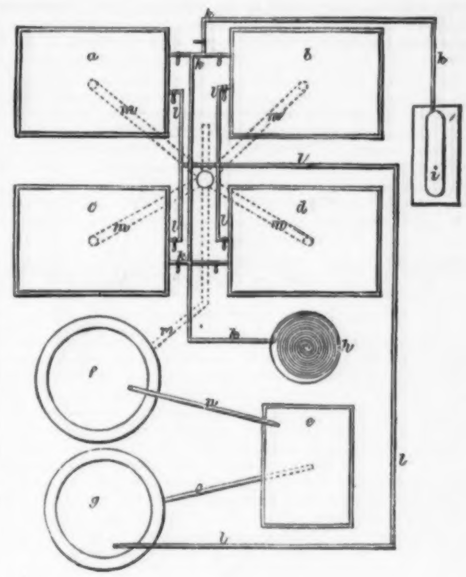


FIG. 5.

and provided with a dome shaped lid, having an inlet pipe, *n*, and outlet pipe, *o*; its capacity is 3 tons. The store tank, *g*, measures 10 ft. in diameter, by 7 ft. deep, has a capacity of 10 tons, and is constructed of ½ in. wrought iron plates. The worm, *h*, is a coil of two in. pipe. The boiler, *i*, is of twenty horse power nominal, and must be placed where it will be impossible for bisulphide vapors to find their way to the fire hole. Force pumps are required to pump the bisulphide from the store tank, *g*, into the extracting vats, *a*, *b*, *c*, *d*, previously charged with the sulphur mineral. When the sulphur has been completely dissolved, the solution is run into the tank, *f*, and thence pumped into the still, *e*, where, by the application of steam in the jacket, the bisulphide is evaporated, and passes into the store tank, *g*, for future use, while the sulphur forms a deposit in the still, and is collected therefrom. When the extracting pans have been emptied of solution, steam is let in so as to force any remaining bisulphide vapors into the worm for condensation and recovery, thus avoiding waste of bisulphide and consequent risk of fire and explosion by ignition of its dangerous vapors. The bisulphide is allowed to remain all night in contact with the charge. The diaphragm at the bottom of each extracting vat may advantageously be covered with bagging cloth to filter flocculent matters from the bisulphide.

Making Roll and Flowers of Brimstone.—For the preparation of "roll" and "flowers of" brimstone, the crude sulphur has to be again subjected to heat. The fusing apparatus, Fig. 6, generally consists of two cast-iron cylinders, *c*, measuring three ft. long by 1 ft. in diameter, closed at one end by a door, *e*, and prolonged into a tube at the other, which leads into a brickwork condensing chamber, *d*. The retort, heated by a fire made immediately beneath, is completely surrounded by flues traversed by the heated vapors, which latter, before escaping to the chimney, heat a little pot, *a*, placed above the retort, and in direct communication with it by means of the pipe, *b*. Into the pot, *a*, is introduced the sulphur intended for distillation. It is raised to a temperature of 257° to 302° F. (125°-150° C.), at which point the sulphur fuses, and flows, drop by drop, into the retort, *c*, where it is vaporized and whence it passes into the chamber, *d*. The floor of this chamber is an inclined plane, converging to an aperture, *g*, by which the liquid sulphur flows

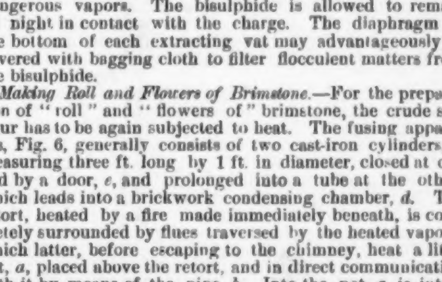


FIG. 6.

out, while the "flowered" portion attaches itself to the walls of the chamber. These two forms (the liquid and the flowered) possess the same degree of purity, and their molecular difference depends only upon the varying grades of temperature under whose influence they are produced. An operation lasts about four hours. The door, *e*, facilitates the removal of spent refuses from the retort; the damper, *f*, regulates the draught and temperature in the chamber, *d*; and the door, *h*, gives access to the interior of the chamber, for the purpose of collecting the flowers of brimstone from the walls. The liquid sulphur, escaping at *g*, flows into a little pan, gently heated by a separate fire, and is thence ladled into wooden moulds suspended in a bath of cold water, to form the so-called "roll" or "stick" brimstone.—*Jour. Soc. Arts.*

* This block is kindly lent by the editor of the *English Mechanic*.

IMPROVED GLASS BLOWING APPARATUS.

ONE of the most striking exhibits in the French Court at the recent Health Exhibition, London, was that of Messrs. Appert Brothers, of 5 Rue des Chasses, Clichy, Seine, and consists of apparatus for blowing glass by means of compressed air. We give, from *Engineering*, illustrations of the various parts of this apparatus, and annex a description of the method of working. The compressed air required for the glass blowing operations is obtained by an engine which should have by preference two cylinders arranged so as to work, if necessary, independently of each other, and each one to be capable of supplying the different apparatus at work with air compressed to the requisite degree. Independent reservoirs to act as accumulators are also supplied, and into these the air is forced at a pressure of about 70 lb. to

The various pipes for the conveyance of the air may be of lead or cast iron, but wrought iron tube is preferred. It is desirable that the pipes and connections should be easy of access in case of leakage. For the pressing of glass, or blowing bottles and window glass, Messrs. Appert prefer the air pipes to be placed in the upper part of the workshop, while for blowing goblets in crystal or glass the air connections should be placed under the floor. In the latter case the communication would be by means of openings provided with stopcocks, which would be placed in convenient positions near the furnaces. Each connection should be furnished with a gauge for indicating exactly the amount of compression. Water gauges are used for low pressures, while metal gauges are required for higher pressures.

The most prominent feature at the stand in the Exhibition is a glassmaker's bench, of which Fig. 1 is an end elevation

tunately got broken in unpacking. These balls are used for cutting up into watch glasses.

Figs. 4 and 5 show a sectional elevation and a plan of a second description of apparatus. This is for blowing glass in a vertical position. In this case the blowing sleeve, *a*, is mounted on a horizontal pivot, *b*, which in turn pivots at *c*, so that a universal motion is obtained. The fork, *f*, is for holding the tube when not in use. This apparatus is more especially applicable to the blowing of thick glass globes of large dimensions and matrasses for chemical purposes, such as the preparation of camphor. It also serves for blowing the balls out of which thin annular pieces of glass placed on candlesticks are made.

A "swan-neck" apparatus, especially designed for blowing glass moulds, is shown in Figs. 6 and 7. In this case the chair or bench is transformed into a stool with steps, *f*. The

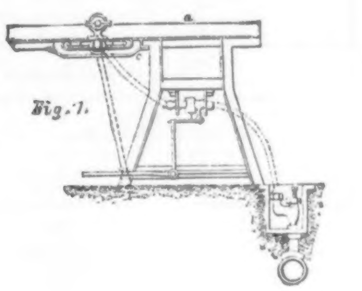


Fig. 1.

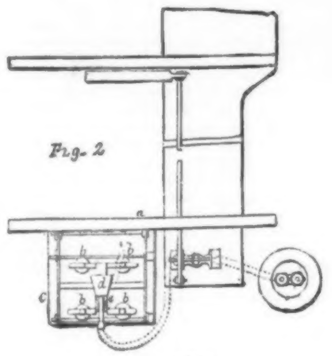


Fig. 2

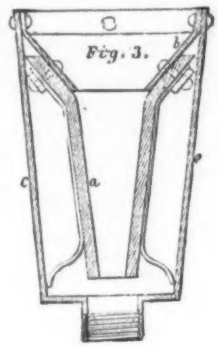


Fig. 3.

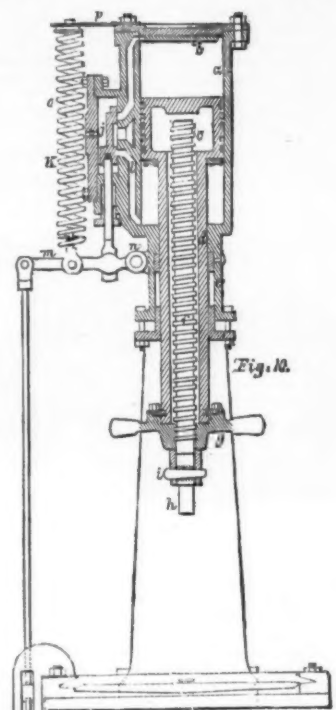


Fig. 10.

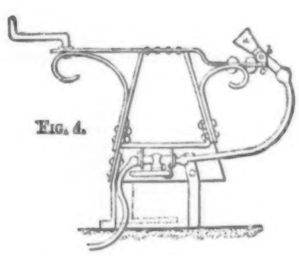


FIG. 4.

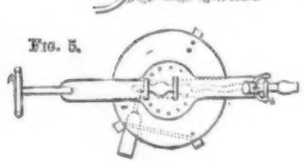


FIG. 5.

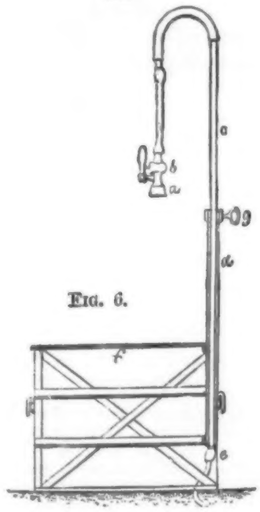


FIG. 6.

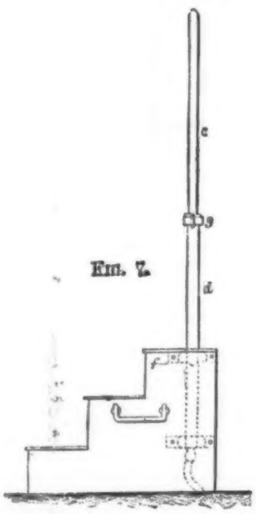


FIG. 7.

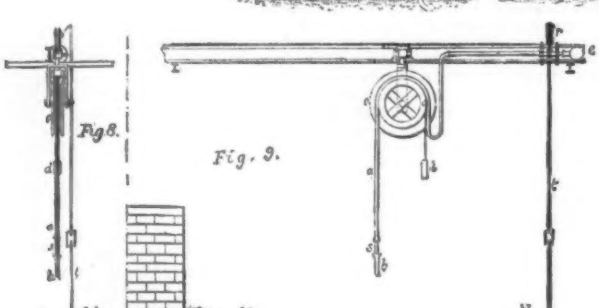


Fig 8. Fig. 9.

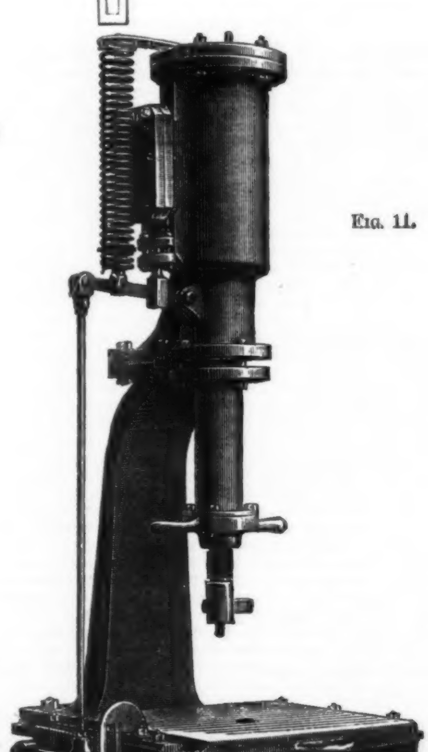


FIG. 11.

APPERT'S GLASS BLOWING APPARATUS.

the square inch. This is considered the most advantageous pressure, not only as tending toward the greatest economy in the utilization of motive power, but also because it allows of accumulators of a moderate size and weight. The total capacity of the reservoirs should be sufficient to enable them to supply the plant in use with air for twelve hours at least. The compressed air is also used for the process of pressing glass, and in this case a storage capacity of two hours is considered sufficient if the engine is capable of keeping up the supply.

The reservoir pressure of 70 lb. is much too high for the purpose of blowing under the ordinary conditions of glass-making, and in practice it is reduced to a lower constant pressure by means of an expansion regulator. The latter may be on the liquid principle, either water or mercury being used, although a dry regulator is preferred.

In the Exhibition the reservoir shown consists of a long cylinder with closed ends fitted with a pressure gauge and having a Pintsch's regulator for controlling the eduction of the compressed air. The expanded air should vary in pressure according to the nature of the glass being manufactured, but should always be constant for the same work. The following are given as minimum pressures:

2	lb. per square inch	for window glass.
2½	" " "	crystal.
3	" " "	white goblet glass or half crystal.
3½	" " "	bottle glass.

and Fig. 2 a plan. This consists of an ordinary bench, on each side of which is placed a couple of long arms as shown, the right hand one being marked *a*. These serve as rests or supports on which, during work, the blowing tube rolls in a horizontal position. The latter is not shown in the illustration, but fits into the socket, *d*, Fig. 2, which is shown in detail in Fig. 3. This socket is supported on a small carriage, which in turn travels on the frame, *c*, being guided by the four horizontal guide wheels on rollers, *b b b b*, and resting on a vertical wheel running on a crossrail as shown in Fig. 1. The socket, or "blowing sleeve," has an India rubber cone, *a* (Fig. 3), attached to the conical ring, *b*, and this in turn is fixed to the case, *c*. The end of the blowing tube forms a plain nipple which fits into the cone and makes a joint. The socket will rotate on its axis, as it is attached to the flexible air tube (shown in dotted lines in Fig. 2) by means of a swivel joint at *e*, Fig. 2, and the blowing tube can therefore be rolled along the bench arms as required. A self-closing cock for controlling the air admission is fixed underneath the bench, and is worked by a pedal.

This bench or chair can be employed for all the various operations of glass blowing, and also for piercing the mass of glass. By it the service of the blower, ordinarily a boy, can be dispensed with. On the stand at the Exhibition a large glass globe produced by this machine is shown. It is about 3 ft. 6 in. in diameter, and was blown at a pressure of 28·5 lb. per square inch. This however is smaller than a globe originally intended for exhibition, but which unfor-

swan-neck, *c*, which will revolve in the guide tube, *d*, has attached to it a flexible tube by which the compressed air is brought to a hand expansion cock, *b*. A set screw, *g*, clamps the swan-neck when required; *a* is the blowing sleeve and *e* the air pipe connection. The apparatus may be moved from place to place as required. It is used for moulding in fixed or revolving moulds and making bottles, gas and lamp glasses, decanters, perfumery bottles, and articles of a like nature.

At the back of the stand is shown a "Universal glass blowing apparatus," which we illustrate in Figs. 8 and 9. This is used for producing such articles as globes, tubes, cylinders, clock shades, etc., or for enabling the glass to be pierced in all possible positions of the blowing iron. The two pedals, *p*, project above the platform, *u*, and by means of a rod, *l*, and lever, *t*, work a stop cock, *r*, situated at the upper part of the workshop. This cock is placed in a branch tube of the compressed air main and is attached to the flexible tube, *a*, which passes over a pulley, *o*, *d* being a counterbalance weight. The coupling sleeve, *b*, fits on to the

end of the blowing iron, and is connected to the tube, *a*, by a swivel, *s*, which turns in a stuffing-box joint. By pressing on one or other of the two pedals, *p*, the cock, *r*, is opened for the purpose of effecting the various operations of blocking, elongating, and piercing the cylinder or other article under process of manufacture.

Several glass tubes are shown at the Exhibition. Two about 6 ft. long and 10 in. in diameter, blown by an air pressure of 3 lb. per square inch, and two others about 14 ft. to 15 ft. long and 6 in. in diameter, which were blown by a pressure of 14 lb. per square inch. The machines we have described are all exhibited at the Exhibition, but in addition to these Messrs. Appert Brothers employ other apparatus used in the process of manufacturing glass. Although none of these have, up to the present, been shown at South Kensington, we give engravings from the drawings of two of them which have been forwarded to us, as they cannot fail to be of interest to many of our readers. In Fig. 10 will be found a sectional elevation of a press used for moulding glass, either by means of compressed air or some other fluid, elastic or otherwise. A perspective view is also given in Fig. 11. The cylinder, *a*, is lined at top and bottom with sheets of India rubber, which act as a cushion to deaden the shocks produced by the strokes of the piston, *c*. A hollow cast iron piston rod, *d*, is fitted as shown, and works through the stuffing-box, *e*. The screw, *f*, can be raised or lowered within the hollow piston rod by means of a fixed nut, *g*, and is prevented from turning in the piston rod by a feather guide. The core, *h*, is attached by the collar, *i*. The slide valve is marked *j*, and the pressure is admitted to the valve chest through the orifice, *k*. The lever, *m*, pivoted at *n*, is used for working the slide valve. By pressing down on the lever, *r*, which works in the slot, *s*, the slide valve is drawn down and pressure is admitted above the piston; when the pressure is taken off the lever, a spring, *o*, causes the valve to rise so that the core, *h*, is automatically raised. The use of this machine relieves the attendant of all heavy work, and enables one man to perform operations that require two people. A much heavier pressure can also be applied than is possible by hand work, and this pressure can be regulated to a great nicety, as may be required. Articles of excessive thinness can also be produced, owing to the rapidity with which the pressure can be applied. This machine can be used equally as well for producing pieces in open or closed moulds, and is applicable for working any kind of glass. Although steam can be used for producing the motive power, the use of compressed air is considered most advantageous for the following reasons: 1. It can be conveyed greater distances without suffering any great loss of pressure. 2. There is no fear of the work being injured by dropping of water of condensation through the stuffing-box. 3. It allows the pieces to be cooled rapidly and effectually by the air used for compression.

If, however, in spite of these advantages, it is found desirable to use steam, an apparatus is employed in which the cylinder is placed beneath the mould, and the piston actuates the core by means of two connecting rods.

PHOSPHORIC ACID FROM SLAGS.

By Dr. C. SCHEIBLER.

THE slags obtained in Westphalia by this process contain 4½ to 8½ per cent. silica, 9 to 14 iron, chiefly in the ferrous state, 17 to 21 phosphoric acid, and 47 to 52 lime. If it is found practicable to separate the phosphoric acid in the form of calcium phosphate, and to eliminate the silica from the residue of the slag, the remainder, consisting chiefly of oxides of iron and manganese, and of lime and magnesia, will prove an excellent material for the production of manganiferous irons and for other technical purposes. The method used at Schalke and Stolberg aims at this decomposition of the slags into biphosphate and into manganiferous iron oxides. For this purpose it is necessary in the first place to convert the ferrous and manganous oxides into the corresponding ferric and manganic salts by a process of roasting, in a current of air, and thus to make them less liable to the action of acids, at the same time to destroy the iron and calcium sulphides present in the slags by oxidation.

At Schalke the slags are roasted in reverberatories with a sloping double sole, 9 meters in length by ½ in breadth, which allow of a complete utilization of the heat. The consumption of coal is trifling. For roasting 1,000 kilos slag, there are required 100 to 130 kilos of coal, and such a furnace roasts in twenty-four hours 15 to 17,500 kilos of slag.

The slag is finely pulverized either before or after roasting. The comminution of the greater part of the roasted slags is easily effected by treating them with steam, whereby the quicklime contained in the slags is converted into hydrated lime, which effects the mechanical disintegration of the slags into a fine powder. Portions which resist this process may be pulverized by disintegrators.

The granules of steel are separated by sifting, or by means of magnets. From the finely pulverized slag the earthly silicates and the calcium phosphate are extracted by means of very dilute acids. This dilution is necessary to prevent the coagulation of the silica, so that the solutions may be easily separated from the residues by filtration or decantation. Hydrochloric acid is to be preferred, as sulphuric acid occasions inconvenience by the formation of gypsum, which envelops the particles of slag. At Schalke 1,180 to 1,250 kilos hydrochloric acid at 30° Tw. are used for working up 1,000 kilos slag. The consumption of acid may be further reduced by previous lixiviation with water, which dissolves out free lime.

The process of solution is completed in a few minutes. The operation is conducted in stirring-tanks, and on settling the solution is run off from the solid residue, which is then stirred up and washed with a still weaker acid.

The solutions are neutralized with milk of lime in large stirring-tanks so far that either all the phosphoric and the silicic acid are thrown down as bicalcic phosphate and calcium silicate, or only so far that only the phosphoric acid and small part of the silica are thrown down, the bulk of the silica remaining in the clear mother-liquor.

To separate the phosphatic mud from the liquid large filter-presses are used, filled by self-acting pumps. The press-cakes contain 65 to 70 per cent. of water.

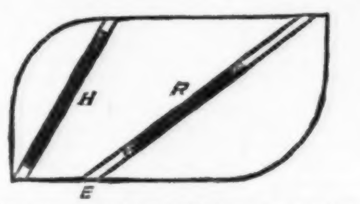
The drying of the cake is effected at Schalke and Stolberg by means of a mechanical apparatus which pulverizes it at the same time. The dry product contains 34 to 38 per cent. phosphoric acid, 6 to 8 silica, 28 to 32 lime, and 1½ to 2 sulphuric acid, along with small quantities of chlorine, ferric and manganic oxides, etc.

On an average 50 per cent of the weight of the slag is obtained as a powder of the above composition. These lime precipitates are well adapted for agricultural processes in virtue of their fine state of division and of their high percentage of phosphoric acid.

The residue amounts to about 30 per cent. of the gross weight of the slag, and when dried at 100° contains—silica, 1·5 to 5 per cent.; phosphoric acid, 0·3 to 4; ferric oxide, 43 to 69; manganic oxide, 10 to 17; lime, 5 to 16; magnesia, 7 to 13. Hence these residues are especially adapted for producing crude irons rich in manganese. Their value is increased by the presence of the alkaline earths, which admits of their admixture with acid ores without any further addition of lime.—*Berg. und Hutten Zeitung.*

HOW TO MEASURE THE HEIGHTS OF TREES.

IT is notorious that optical instruments are generally sold at very far above their true value; whether the paucity of buyers raises the price or the high price limits the number of purchasers, I cannot say. Having taken to growing spars instead of rigging them, I have transferred my sextant to a younger relative, who I hope may maintain the honor of the family in her Majesty's navy. This, however, left me without the means of measuring the height of my trees, and as the advertised instrument cost far more than I am inclined to give, I set to work to manufacture one for myself. Having procured a pair of toy mirrors 1¾ inches square, I procured a piece of 1-inch board 2 inches by 4, having two of the corners rounded off as in the figure, and upon it with a fine saw I cut two grooves a quarter of an inch deep, so that if produced they would form an angle of 22½°. Into these I placed vertically the two mirrors, R and H, facing one another, and wedged them with thin strips of wood and japan varnish. The silvering should be taken off half an inch of the upper part of the mirror, H, to render it transparent. To use the instrument, fix a piece of white paper to the stem of the tree near the height of the eye at the point of observation; then at a short distance hold the reflector, R, nearly vertical, and with the eye at E, the top of the tree will be seen in H. Walk backward or forward until this reflection coincides with the white mark, and if the mirrors are set correctly the distance from the tree will be equal to the height above the mark. The probability is that an amateur will not hit the exact angle, and this must be tested by erecting two poles at, say, 100 feet apart, and walking from the left-hand pole at right angles to the line between them, and measuring the distance at which



A SIMPLE TREE MEASURER. (Scale half size.)

the poles coincide in the instrument. Then divide the first distance by the second and the result will be the ratio by which the base must be multiplied to give the height of the tree. In my own instrument this is 0·87, but a smaller angle would give a longer base, and therefore a more accurate result; indeed, with a round headed tree the short base cannot be used correctly. The whole apparatus, after being japan varnished, did not cost me a shilling.—*H. K., in the Gardeners' Chronicle.*

HOW TO MAKE CHEESE FOR HOME USE.

THE following essay on "How to make the best and cheapest cheese for home use" we take from the *Farmers' Advocate*, published at Ontario, Canada. The author, Miss Maggie Webster, of Prince Edward Island, is a practical cheese maker. Her essay won one of the prizes offered by the *Advocate*. It may help those who are desirous of making a few cheeses for home use, during the sultry days of August, when it is often difficult keeping the cream sound for butter making.

Every pound of cheese requires ten pounds of milk, and a ten-pound cheese is about as small a one as can be conveniently made. A clean tub which will hold the milk, and a boiler large enough to hold ten gallons, will be needed. A small press, which any smart boy can make, with a lever to hang a stone upon, will also be required, and then the "know how" is all the rest. Making cheese is a chemical operation, and depends greatly, like all other such work, upon temperature. One cannot be safe without a thermometer, as a rule of the thumb will not be precise enough.

The first thing to do is to bring the milk to a temperature of 90°. This makes a soft cheese; a higher temperature will make a hard one. The milk may be of two milkings: the evening milk, set in a deep pail in the cellar, and stirred late at night and early in the morning, to keep the cream from separating; and the morning milk mixed with it as it is strained after milking. If any cream has risen on the evening's milk, it may be skimmed off. The evening's milk may be warmed to 100°, and then added to the fresh morning's milk, which will be about 80°; the whole will then be about the right temperature, which is 90°. The rennet is then added. This is the liquid made by steeping a piece of the dried stomach of a sucking calf in warm water. For 100 pounds of milk, or 45 quarts, a piece of the rennet about as large as one's thumb, or two inches long by one inch wide, is put in a quart of warm water in the evening, with half a tablespoonful of salt. In the morning this liquid is strained into the warmed milk in the tub, and well stirred through it. The tub is then covered to keep the milk warm until the curd is formed, which will be in about half an hour. As soon as the curd is formed enough to cut, a long-bladed knife is drawn through it both ways, so as to cut the mass into inch cubes. This causes the whey to separate, and when this separation has been effected, the whey is dipped out or drawn off, and the curd gathered into a mass at one side of the tub, the tub being raised at one side to cause the whey to drain off. The tub is kept covered to retain the heat, or if the curd has cooled considerably, the whey that has been drawn off is heated up to 100° and turned on to the curd until it is warmed through again, and the whey is then drawn off. The curd remains thus for about an hour, until it attains a very slight degree of acidity, when it is broken up fine with the hands, salted with about half an ounce of salt to the pound of curd, and put into the hoop.

The hoop for a ten-pound cheese should be about eight inches in diameter and ten inches deep. It has neither top nor bottom. It is placed upon a smooth board or a bench, and the curd is pressed down into it with the hands. When the curd is all loose, a cover is placed upon it, and the hoop is put under the lever, which presses down upon a block resting in the cover. Very little pressure is required, and this only until the curd has become solid enough to keep its shape; 24 hours in the press is quite enough, the cheese being turned twice in that time. The cheese is then taken out and the outside is rubbed with butter and wrapped in a cotton bandage, the edges of which are turned down on the two faces for an inch or so. The cheese is then placed in a cool room or cellar, and is turned every day for a month, after which it should be turned once a week for another month, when it is fit for use.

A very nice cheese for immediate use may be made in smaller quantities. The milk is curded in the same way as above mentioned, but as soon as the curd is set it is dipped out and put into moulds six inches in diameter and three or four inches deep, resting upon clean straw, through which the whey drains off on to the board under it and drops into a pan. The moulds with the curd in them are turned daily, and in three or four days it is firm enough to be turned out of the hoop on clean straw, when it is sprinkled with salt and turned daily for a month, when the cheeses may be put into a cool cellar to ripen for a week or two longer, and are fit for use. Skimmed milk cheese made in this way are very well flavored and are very nutritious, and furnish an agreeable change of diet for a farmer's family, and indeed sell very readily in village stores when they are made well.

NATURE OF MALARIA, AND ITS PECULIARITIES OF ORIGIN AS TO PLACE.*

By J. W. DOWLING, M.D., New York City.

No disease-producing element is more generally distributed over certain large portions of the face of the globe than that which gives rise to the various forms of malarial illness. I use the term illness rather than fever, for in my own experience the most distressing—the most harassing—derangements of the system resulting from the absorption of this poison, and, too, those most difficult to combat, are not characterized by a febrile rise of temperature.

I take the ground that the poison known as malaria is the same in all parts of the globe; and that this poison taken into a system susceptible to its action produces a peculiar form of illness of greater or less intensity varying with the amount of poison absorbed and the susceptibility of the individual to the action of this particular poison. In some a simple benign intermittent fever is the result; in others, or in the same individual at another time, a masked intermittent with its various and perplexing symptoms; in others, or in the same individual at another time, a pernicious intermittent with its protracted chill, and as a result a distended and partially or completely paralyzed heart; or a remittent fever; or a continuous fever; all frequently followed by the so-called malarial cachexia—a condition of chronic malarial poisoning—giving rise to periodic illness of every kind and character cropping out whenever the system from any cause, sickness or other kinds, a cold, an over-indulgence in the pleasures of the table, excessive sexual indulgence, over mental exertion, grief, fatiguing physical labor, or the excessive use of tobacco, is brought below a certain level of health.

From time immemorial, the brains of investigators have been taxed to ascertain the origin and nature of this poison; and as years, decades, centuries, have rolled by, bringing greater and greater familiarity with the resulting disease, and as they have noted the appearance of malarial illness in localities supposed from the nature of the soil and surroundings to be entirely free from a possibility of its existence, and have noted its disappearance from other localities where it had held supreme sway for years, they have become more and more perplexed, until the question has actually been asked: "Is there in reality such a substance as malaria?" with strong and to some conclusive arguments tending to prove that malarial illness, so called, was not the resultant of an absorbed poison, but was either the effect of heat on the "temperature centers" of the body (Dr. Reber), or the result of enervation from privation of electricity caused by evaporations of water (Dr. Penn, Trans. of Med. Soc. of Tenn., 1879), or the effect of the debilitating effects of long continued heat or of sudden absorption of heat following sudden changes of temperature; heat without sudden alternations being powerless (Oldham in his work entitled "What is Malaria?").

In chapter 21 of his work, Dr. Oldham gives the following synopsis of the views therein expressed, viz.:

1. Exposure at night in a malarious locality necessarily involves exposure to chill.

2. All effects produced by so called malarious influence can be caused by rapid abstraction of animal heat without intervention of any specific poison.

3. Exposure to chill is admittedly the cause of the diseases that are constantly associated with malarial fever as well as of the recurrent attacks or so-called relapses of the fevers themselves.

4. The effect of continued exposure to a high temperature is at once to diminish the heat generating powers of the system, and to increase the susceptibility to malarious fever as well as to aggravate the intensity of the disease.

Under all these circumstances, says Oldham, it is impossible to arrive at any other conclusion than that malaria is chill.

It has been and is an easy task to conclusively refute the arguments offered in support of these theories. Space will not permit of our reviewing them here. Suffice it to say, that these theories have not been favorably received by most investigators, for superficial observations were sufficient to show conclusively that the so-called periodic or malarial illness in various portions of the world could not be accounted for by the theory of chill, or by the effect of heat on the temperature centers of the body, or by enervation from privation of electricity caused by evaporation of water.

In fact, it is generally conceded that malarial fever owes its origin to a *poison*, which, taken into a system susceptible to its action, produces a peculiar form of illness, varying with the amount of this poison absorbed and the susceptibility of the individual exposed to the action of this particular poison.

Some authorities, standing high in the medical world, have been willing to acknowledge their ignorance as to the nature of this poison. Bartlett, in his work on the "Fevers of the United States," says: "The nature and composition of this poison are wholly unknown to us. Like most other analogous agents, like the contagious principles of small-pox and typhus, and like epidemic poisons of scarlatina and cholera, they are too subtle to be recognized by any of our senses; they are too fugitive to be caught by any of our contriv-

* A paper read before the American Institute of Homœopathy, 1883.

ances. Neither the strongest lenses of the microscope nor the nicest analyses of chemistry have succeeded in discovering the faintest traces even of the composition and character of these invisible, mysterious, and stupendous agencies. As always happens in such cases and under similar circumstances, in the absence of positive knowledge, we have been abundantly supplied with conjecture and speculation; what observation has failed to discover, hypothesis has endeavored and professed to supply." He says: "It is quite unnecessary even to enumerate the different substances to which malaria has been referred. Among them are all the chemical products and compounds possible in wet and marshy localities; moisture alone, the products of animal and vegetable decomposition, and invisible living organisms."

In regard to the alleged agency of animal and vegetable decomposition in the production of malaria, he says: "We have no positive knowledge on the subject; it is possible enough that this decomposition may produce the poison, but there are reasons for doubting it. One of these reasons is to be found in the common and notorious fact that this same decomposition is constantly going on without giving rise to periodic fever."

Watson says: "Where there is much heat and much moisture, there we usually find also much and rank vegetation, and much vegetable dissolution and decay. The belief was as natural, therefore, as it had been general, that the putrefaction of vegetable matters was somehow or other requisite to the formation of the poison that exists so commonly in swampy situations. This belief has descended almost unquestioned, from the time of Lancisi; and it obtains almost universal acceptance, I fancy, among physicians of the present day. Yet very strong facts have been adduced to show that the decomposition of vegetable substances is only *an accidental* though a frequent accompaniment of the miasm, and not by any means an essential condition of the evolution." "In the first place, the decomposition of vegetable matter goes on abundantly *without the production of malaria*. The rotting cabbage leaves of Covent Garden and those which taint the air of the streets from the neglected dust-holes of London, during the hot weather of summer, *give rise to no ague*. The same may be said of the putrefying and offensive seaweed, which is deposited in large quantities upon some very healthful parts of our sea coast. But the converse facts are the most remarkable and conclusive. Marshes are not necessary to produce malaria. It has been shown that vegetation is not necessary, that the peculiar poison may abound where there is no decaying vegetable matter and no vegetable mater to decay."

After mentioning some striking facts detailed by Dr. Ferguson, in his paper on the "Nature and History of the Marsh Poison," tending to prove the above statements, Dr. Watson says: "These facts, and facts like these, seem to prove that the malaria and the product of vegetable decomposition are two distinct things. They are often in company with each other, but they have no necessary connection."

Of the hypothesis of the animalcular or cryptogamic nature of this poison, he says: "*It may be safely said of it that it may be made to correspond to the ascertained phenomena in connection with the etiology of malarial diseases better than most other hypotheses, and that it is less embarrassed by objections which cannot be met, and by difficulties which cannot be overcome.*"

Laveran, in his work entitled "Impaludiome," asserts that malaria is caused by parasitic pigmentary elements or melaniferous leucocytes.

Niemeyer attributes malaria to low vegetable organisms, whose development is chiefly due to the putrefaction of vegetable substances.

Liebig associates malaria with the deoxidizing caused by putrefactive decay.

Barker, in his work entitled "Malaria and Miasmata," teaches that an organic poison comes into contact with decomposing matters in the soil and acts as a ferment, producing compounds which, when breathed, become poisonous, developing the condition known as malarial illness.

I, accepting Leibermeister's definition of the word infection in considering the nature of malaria, take the ground that the poison known as malaria is infection. Leibermeister defines infection as a poison which differs from ordinary poisons in the fact that it can reproduce itself under favoring conditions to an endless degree.

I take the ground with him that infection consists of living beings—germs, or low organisms; that the infection or germs of malarial illness can produce only the various forms of malarial illness. So with the infection or germs of typhus, typhoid, scarlet fever, measles, small-pox, syphilis, cholera, yellow fever, etc.; they can produce only their own specific diseases.

All pathological conditions arising from the presence in the system of infection are classed by Leibermeister under the one general heading of infectious diseases. These are subdivided into acute and chronic infectious diseases; and, further, into miasmatic and contagious diseases. The miasmatic include all diseases owing their origin to miasm—which is defined as "a specific excitant of disease which propagates itself *outside of and disconnected from a previously diseased organism*." "Miasm originates from without; taken up into the body it can call a specific disease into action, but it cannot spread the disease any further by conveying it from a diseased to a sound person." The contagious include all diseases owing their origin to contagion, which is defined as "a specific excitant of disease which originates in the organism suffering from the specific disease."

These are further divided into purely contagious, purely miasmatic, and miasmatic-contagious diseases.

"In the purely contagious the poison can be conveyed from one individual to another by contact, and mediately from the vaccinator's lancet, from other instruments, from clothing, through third persons, and, in many of the purely contagious diseases, by the air; the poison having no special stage of development to pass through on the way from the infecting organism to the one to be affected, but at the time of infection it is essentially in the same condition as when given up by the organism yielding it." "Included under this heading are measles, scarlet fever, variola, vaccinia, typhus, diphtheria, glanders, malignant pustule, rabies, virulent ulcers, blenorrhœas, syphilis, pyæmia, and puerperal fever."

"In the *purely miasmatic*, which includes the *malarial diseases*, the morbid poison develops itself externally—within the body it appears to vegetate for an indefinite time. Thus far it has not been known that the germs reproduced within the human system can be conveyed to other men, and can infect them, or that they can again escape from the body and reproduce themselves further."

In the *miasmatic-contagious diseases*, "the poison cannot be conveyed from diseased to healthy individuals by mere contact. First of all it is drawn from without; is then generated in the diseased individual, but is not in a condition to infect others when it first leaves the body, but must undergo a subsequent development before it is in a condition to produce its peculiar disease in other individuals. This subsequent development occurs when the discharges from patients suffering from this class of diseases are permitted to remain standing for a length of time, but particularly when they come in contact with great quantities of organic substances that readily decompose, as in water closets, dung heaps, sewers, and also in the soil of inhabited localities that are damp and rich in organic debris. In this stage of development, there seems to be a considerable increase of the poison, and after this reproduction it is again in a condition to multiply further in the human body and produce the disease."

Under this heading are included "cholera, typhoid fever, dysentery, and probably also yellow fever and the plague."

Recent investigators include *croupous pneumonia* among the infectious diseases, but no conclusion has been drawn as to which of the above classes it belongs.

We conclude then:

1st. That there is a disease-producing poison known as malaria.

2d. That it invariably proceeds from without the system.

3d. That it is capable for reproducing itself under favorable circumstances to an unlimited degree.

4th. That this poison is composed of living beings—known as bacteria.

A bacterium Dr. Belfield defines as a mass of matter which possesses a definite size and shape; may or may not exhibit motion; has a certain chemical composition; and is capable of growth and reprod uction; is in short a living organism.

At the present time, scarcely a doubt seems to exist as to the truth of the first three of these conclusions. Consequently, it will be unnecessary to advance arguments in their favor.

The same can hardly be said of the fourth and last. The germ theory of disease is comparatively in its infancy, although even in the seventeenth century the theory that certain diseases arose from the presence in the system of low organisms—of living beings—was strongly advocated by many prominent authorities. It will not be out of place for us to say a few words in reference to this subject, defining the term germ theory of disease, and bringing forward a few of the most conclusive arguments to prove that malaria is composed of germs, or, as they are now called, of bacteria.

The subject is conclusively argued by Leibermeister in the first volume of Ziemssen's Encyclopedia, but more recently and quite as conclusively by Dr. Belfield in the Cartwright Lectures of 1883, published in full in the *Medical Record*. He says: "*The germ theory supposes, that all infectious diseases are caused by the vital activity of parasitic organisms*," and supports the theory by reference to the stage of incubation, the unlimited reproductive power of the virus, and the cyclical course and self-limitation with which these diseases are generally characterized. He says: "The stage of incubation can be explained by the assumption of no unorganized virus. All mere chemical compounds with which we are acquainted, even the ferments ptyalin and pepsin, begin to manifest the characteristic effects as soon as absorption has occurred." All infectious diseases, including malarial illness, are characterized by a stage of incubation; and the period which elapses between the absorption of the poison and the development of the disease, according to this theory, is the period during which the organisms which have been taken into the system are multiplying till their number is sufficient to produce their characteristic disease—the period varying with different disease-producing germs, with different infectious diseases, some requiring but a short time, others days, and others even weeks.

The unlimited reproductive power of the virus of these diseases can be accounted for in no way except by the theory of organized poisons. "No unorganized poison, acid, salt, alkaloid, ferment is as present known which is capable of manifesting the phenomena shown by the virus of syphilis, variola, scarlatina, etc." "With a minimal quantity of vaccine virus we can vaccinate a child and obtain vaccine virus from him. From this child ten and even more in turn, and so on, so that, what at first was a scarcely appreciable quantity of the virus, is sufficient to produce the disease in 1, 10, 100, 1,000, 10,000 children, and so on, *ad infinitum*. There is no limit to the extension of the disease until there are no individuals left to whom the poison can be successfully conveyed. So with all of the infectious diseases, the poison can be multiplied to an endless extent." (Leibermeister.)

How account for the cyclical course and self-limitation of infectious diseases? This question, according to Belfield, has not been decisively answered. "Several facts suggest that the products of their own vital activity arrest further development." The soil finally becomes unfit for their further development, and with the death of the bacteria existing in the system commences the recovery of the patient, provided the presence of the disease-producing element does not prove fatal in its results.

If the truth of this theory is acknowledged as regards the origin of the purely contagious and miasmatic-contagious diseases, the application of it to the malarial diseases may be questioned from the fact that their cause is not so well marked as is that of the other infectious diseases. Notwithstanding this fact, the peculiarities by which malarial diseases are characterized, the peculiar habits of the poison producing the disease can be better accounted for on this theory than by any other. I will say more, they can be satisfactorily accounted for by this theory, as is evident to any one who carefully peruses the literature of the subject as it relates to other infectious diseases.

We now proceed to consider the peculiarities of malaria as to locality? Bartlett says: "With certain limited exceptions, it may be said to encircle the earth in a broad belt, parallel with the equator; its northern and southern boundaries quite irregular in their disposition—now approaching to the line of the tropics, and now receding from it. The portions of this immense territory which are entirely exempt from periodical fever increase with the distance from the equator; while within the tropics and along the range of several degrees beyond them, these portions are confined mostly to certain geological formations, and to elevated situations.

"The particular regions most extensively and constantly the seat of malaria disease in its more malignant forms are low lying and wet lands situated in hot climates and covered with a rank and spontaneous vegetation—the flat, wooded sea coasts, the interior swamp and marshes, and the rich alluvium of the deltas and courses of the great rivers."

The poison known as malaria seems to emanate from the earth. It floats in the atmosphere, hovering near the surface of the earth, and undoubted evidence exists of its being carried by the wind from malarial spots to localities which would otherwise be entirely exempt from it—to a certain extent purifying the atmosphere of the regions where it is generated.

It is more apt to be found in localities where the upper crust of the earth is moist and subjected to the action of the heat of the sun. In warm climates wherever there is a subsoil of clay, or a rocky bed covered with a thin layer of soil, malarial diseases are almost surely to be found.

As a rule, *wherever is found a fog which hovers but a few feet from the earth's surface, making its appearance with the setting of the sun, and gradually disappearing with its rising, malaria is sure to be generated.*

It is found also in localities entirely free from moisture, in some sandy regions, sandy to the depth of many feet where there is no vegetation, but this is the exception.

It is affected by the temperature of the atmosphere—frost rendering it entirely inactive. Trustworthy authorities assert that after once being submitted to an atmosphere of or below the freezing point, it is not again operative in producing disease till it has been exposed to a temperature *above* sixty degrees Fahrenheit.

It is more active at night than during the day. Evidence has accumulated to prove that certain localities exceedingly dangerous at night are perfectly healthful during the day. Watson records an instance. "In 1776, the Phœnix, ship of war, was returning from the coast of Guinea. The officers and ship's company were perfectly healthy till they touched at the island of St. Thomas. Here nearly all of them went on shore; sixteen of the number remained for several nights on the island. Every one of them contracted the disorder, and thirteen of the sixteen died. The rest of the crew, consisting of 280 men, went in parties of twenty or thirty on shore in the day, and rambled about the island, hunting, shooting, and so on; but they returned to the ship at night, and not one of those who so returned suffered the slightest indisposition. Exactly similar events occurred the following year with the same ship at the same place, when she lost eight men out of ten who had imprudently remained all night on shore, while the rest of the ship's company, who after spending the greatest part of the day on shore always returned to their vessel before night, continued in perfect health." These are but two of many examples of the same kind.

The fact that those remaining on shipboard did not contract the disease proves one of two things, viz., that the wind was not blowing from the land, or that water has the power of absorbing the malarial poison.

It has been conclusively proved that miasmatic atmosphere passing even over a small body of water becomes inoperative. The poison, hovering, as it does, near the surface, is undoubtedly absorbed by the water. Proof positive exists that water which has absorbed large quantities of malarial poison can impart intermittent fever to those drinking of the water so impregnated.

In proof of the above assertion Watson cites the following: Dr. and Mrs. Evans, of Bedford, were both attacked with ague while staying at Versailles, in the year 1845. The water used there for domestic purposes is brought from the Seine at Marli. A large tank in which it was collected for distribution to a particular quarter, happened at that time to be damaged; and the mayor of the place provided a new supply of water consisting of the surface drainage of the surrounding country, which is marshy. This water the inhabitants of Versailles would not drink; but Dr. and Mrs. Evans, living at a hotel, drank of it unwittingly. It was made use of by the regiment of cavalry also. The result was that they who drank the water suffered of intermittent fever of so severe a type that seven or eight of the soldiers died in one day. Upon careful investigation it was ascertained that those only of the troops were attacked who had drunk the marsh water; all the rest, as well as the townspeople, having escaped, though all of them breathed the same atmosphere. He records other instances of the same kind. It has long been known that the poison of other of the infectious diseases could be conveyed to an individual in water.

The poison, according to Watson, is attracted by and adheres to the foliage of trees; it is not absorbed by them, for the disease is almost surely produced in those who sleep or even remain for any length of time under these trees. This fact is taken advantage of by the natives of certain malarial sections, who plant trees between their residences and the marshy districts, that a barrier may be interposed which will protect them from the poison.

The culture of the soil lessens the generation of malaria. Certain plants and trees apparently destroy the poison, for when they are cultivated in malarial sections the disease soon disappears. The eucalyptus is an example of this.

Malaria, from its almost constant existence in marshy regions, has been known as marsh miasm, yet there are swampy regions in hot climates that are entirely free from malarial diseases.

It is less apt to be generated where the marshes are covered with a depth of water, and malarial diseases are more likely to abound when the marshes are covered with a thin sheet of water exposed to the heating influence of the sun. In such localities decomposition of organic matter is rapid, and we have one of the elements favorable for the generation of malaria.

Marshes that have dried up offer the most favorable conditions for the development of the poison.

Marshes formed partly of salt, partly of fresh water are exceedingly noxious from the destruction of fresh water plants by the action of the salt water—thus producing a larger amount of decomposing vegetable matter.

Marshes resting upon a substratum of sand or peat are more wholesome than those resting upon limestone, clay, or mud.

In localities once malarious the upper crust of the earth seems to become oxidized in time if left undisturbed. The building of railroads and the turning over of the soil for improvements of various kinds seem to develop the poison anew, as if it had existed below but was unable to escape.*

Instances are on record where earthquakes and volcanic eruptions have been followed by the appearance of malaria where it was previously unknown. The poison having been undoubtedly shut up, as it were, beneath the surface of the earth.

* During the past year, owing to the turning over of the soil necessary in the building of the West Shore Railroad, malarial fever has been generated in many of the towns on the west shore of the Hudson River, in localities, too, where it had never been known to exist, or which had been free from it for years.

As was before stated, malaria will sometimes, in a comparatively sudden manner, leave a section and appear in another, without any known changes having occurred in the condition of the soil.

Malaria is most active during the summer and fall. A remarkably wet and warm summer will develop the poison to an alarming degree, as will a remarkably dry and hot summer. This is accounted for, in the first instance, by the wetting of the soil, loaded with organic matter, and the subsequent action of the sun's rays upon it, producing decomposition, which renders the soil favorable for the generation of the poison; in the second instance, by the fall in the height of the water beneath the surface of the earth, owing to evaporation, leaving a stratum moist but uncovered by water, ready to be acted upon by the heat of the sun.

According to most authorities, the requisites for the development of the malaria are organic matter, heat, and moisture; but it has been proved that it may exist where there is no organic matter—where there is no moisture: although heat seems to be in every instance a necessary requisite.

For the above facts I am mainly indebted to Ziemssen's Encyclopedia and Watson's Practice of Medicine—see articles on Intermittent Fever.

Finally, the germs of malaria may exist for an unlimited period and be generated in the human system, remaining dormant, as it were, so long as the system is above a certain level of health, but if it become reduced from any cause, and brought below that certain level, the poison becomes active, to generate itself and produce its specific disease.

I have positive evidence of this in my own person, in that of members of my family, and in almost innumerable instances among patients whom I have treated for this disease. In many instances patients have apparently been cured of the disease, resulting from exposure to malarial atmosphere, and have remained perfectly well for months—even years in some cases—and then without fresh exposure, and, too, at a season of the year when malaria is supposed to be inactive, from an ordinary cold, a debauch, or any excess which has brought the system below the proper level, an attack of intermittent fever has been developed, which yielded to measures calculated to elevate the general tone of the system.

It has been proved that the spores of certain bacteria will resist influences which would destroy the bacteria themselves. "Their vital activity is sometimes unimpaired by prolonged boiling, or by immersion for months in absolute alcohol, either of which procedures destroys mature forms. The spores, seem under ordinary conditions, the impersonations of immortality; time seems powerless to weaken them." (Belfied.)

It certainly seems as if it were so with the spores of the bacteria producing malarial illness—they apparently remain for years in the human system, and so long as the soil is not ripe for their development into the mature form they are harmless, but so soon as the soil is brought to a condition fitted for their growth, from any cause, they mature and multiply, producing their peculiar disease.

We see this demonstrated without the body. In malarial sections certain seasons, certain years, are comparatively free from the malaria and its diseases, while other seasons, other years, are remarkable for its virulence. This is easily accounted for by the condition of the soil, varying, as it does, with the amount of moisture and heat. Belfield says, as is well known by all pathologists who have investigated this subject, "Every moist substance of organic origin, and all water containing even a trace of organic matter, is favorable soil for one or more varieties of bacteria. The upper layers of the earth containing these essential ingredients, and remaining comparatively warm, constitute a continual breeding place for these organisms. The minuteness and lightness of bacteria explain their presence in the atmosphere. They are swept by currents of air from dry or moist surfaces; they float in clouds of dust; they are carried by insects. The persistence of their vitality, the rapidity of their propagation, results in practical ubiquity." These facts have been proved with regard to certain forms of bacteria, and taking into consideration the known facts relating to malaria, is it not probable, more than probable, almost certain, that this poison is composed of bacteria?

As an evidence of the peculiar manner in which malaria may be generated in certain healthful localities, I would mention the following remarkable case, which was related to me by my friend, Prof. St. Clair Smith:

A box of growing plants, in earth which was covered with mould, was placed in the warm sitting room of one of his young lady patients who had never had malarial illness of any kind, and who had never, to her knowledge, been exposed to the action of malarial poison. Soon she developed an intermittent fever in mid-winter. The disease resisted medicinal measures so long as the box of earth was permitted to remain in the room. Finally the box was removed, and she entirely recovered. Later, it was brought back, and she was again taken down with the disease. The box was again—this time permanently—removed, and the disease responded readily to remedies, there being no further return of it.

A patient of mine built a magnificent house on the sea shore, far from any malarial region; no such disease had ever been known there. The soil was sandy; even a blade of grass would not grow. He wanted a lawn, and consequently went to the expense of having several hundred carloads of earth brought from a distance, and, too, from a section which I have since learned is malarious. He had a beautiful lawn, which was the envy of his neighbors, but in the fall he, with every member of his family, was taken down with malarial fever.

"PRICKLY HEAT."

By HENRY T. WHARTON, M.A. Oxon, Honorary Surgeon to the Kilburn Dispensary, etc.

THIS distressing affection, so common among Europeans in tropical climates, is too rarely met with in England to figure in our text books under anything but its mere name of "lichen tropicus." The apparent impossibility of relieving the fearful burning heat or the tormenting prickly itching seems to excuse dermatologists from even suggesting a remedy. Nevertheless the disease, although seldom recognized, is far from being unknown in this country. A well-marked case which has come under my observation, and which has ended in a complete cure, seems therefore worthy of being recorded.

My patient, a medical man, after passing the age of thirty suffered year by year continually increasing distress as each summer came round. He is a man of exceptionally good health, who knows nothing of indigestion, biliousness, or liver complaint in his own individual experience. At last his "prickly heat" became intolerable. Not only was the follicular lichenous inflammation so conspicuous on his back that he could not bear to take a Turkish bath in public, but the eruption would appear in considerable patches on his forearms, so that he was ashamed to turn up his shirt-sleeves in ever so troublesome an obstetric case. The disfigurement was almost as serious a matter as the pain. Yet, after having been out at night he would often return to his bed to suffer hours of the torture of his "prickles;" the least increase in the action of the skin brought them on; nor did any treatment prove adequate to bring the slightest relief. From May to November he was a martyr to his troublesome malady. He consulted all his friends and more than one distinguished specialist. His efforts to get cured were as unremitting as they were unavailing; no known art could aid him.

At last it occurred to me that perhaps the light short-sleeved India-gauze vests that he wore in the summer had some share in the causation of his agony; they were too thin either to absorb the perspiration or to protect the skin from sudden (but perniciously grateful) chills. In fact, his endeavor to keep cool was the very cause of his suffering from the heat. I accordingly advised him to wear throughout the summer the thickest long-sleeved vests made entirely of wool, such as he wore in the depth of winter. The result was the absolute cessation of his experience of "prickly heat." All last summer, and up to the present date of this, he has never felt a symptom of the recurrence of his dreaded agony.

PAPAVER UMBROSUM.

I may further mention, as it may throw some light upon the case, that for years my patient suffered a transient attack of urticaria—itching without any outward signs—after a cold bath. Since he has taken to the constant use of hot water for all his ablutions, this irritation has never returned. It would be interesting to learn whether Indian practitioners have ever essayed to combat the excruciating anguish of "prickly heat" by any method similar to mine.—*Lancet.*

PAPAVER UMBROSUM.

WHETHER this is anything more than a variety of the common field poppy, P. Rhœas, may well be doubted, but this is a matter of indifference to most people, who will be contented to take the plant on its own merits without prying too inquisitively into its origin. The brilliant crimson color of the petals is set off by a large blotch of shining black, which produces a most striking effect. Muller tells us that the common field poppy contains no honey, and is moreover to a large extent, though not exclusively, fertilized by its own pollen. Assuming this statement to be correct, it is obvious that the presence of the blotch is likely to be of benefit to the flower or to its offspring, by the invitation it holds out to insects. Muller tells us that the flowers of P. Rhœas are visited by pollen-eating insects only as there is no honey for those who are partial to that substance; it would therefore be interesting if any reader who has the umbrosum poppy in bloom would observe whether honey is formed therein, as the presence of the blotch would lead us to infer must be the case. The fleeting nature of the flower, which Burns alluded when he declared that

"Pleasures are like poppies spread—
You seize the flower, its bloom is shed,"

is obviated by the abundant succession of flowers. As an annual of the easiest possible culture, this plant may be recommended with safety to the humblest cottager, who with it may produce an effect not to be excelled by those who array themselves in purple and fine linen.—*The Gardeners' Chronicle.*

THE ORIGIN OF BITUMENS.

By S. F. PECKHAM, A.M.*

SPECULATION regarding the origin of bitumens has been pursued during the last half century along several quite different lines of investigation, and has been influenced by several different classes of experience. Generally speaking, these lines fall into three different classes, and embrace those who regard bitumen as a product of chemical action, those who regard it as indigenous to the rocks in which it is found, and those who regard bitumen as a distillate produced by natural causes.

The argument for a purely chemical origin of petroleum was first brought to the serious attention of scientific men by Berthelot in 1866. He found that when carbonic acid or the earthy carbonates were brought to react with alkali metals at a high temperature, oily fluids were formed similar to or identical with those found in petroleum. Byasson produced the same fluids by causing steam, carbonic acid, and iron to react; and Cloez produced them by the reaction of boiling water upon a carbide of manganese. The chemists of this school assume that the alkali metals, iron at a white heat, and spiegeleisen, with other raw chemical reagents, exist in the interior of the earth, and that petroleum is formed by the reaction upon them of carbonic acid in water, which everywhere infiltrates the terrestrial crust. These chemical theories are supported by great names, and are based upon very elaborate researches, but they require the assumption of operations nowhere witnessed in nature or known to technology.

M. Coquand, who has written so fully upon the occurrence of bitumen in Albania and Roumania, and C. H. Hitchcock, have both advocated the theory that all forms of bitumen are produced by a chemical reaction in which marsh gas is converted into more condensed hydrocarbons, appearing as fluid, viscous, and solid bitumens. In so far as this theory expresses the fact that maltha represents an intermediate stage in the transformation of petroleum into asphaltum, and recognizes the relation existing between marsh gas and the petroleum compounds, it is entitled to consideration; but in the chemical processes of nature, complex organic compounds pass to simpler forms, of which operation marsh gas, like asphaltum, is a resultant and never the crude material upon which decomposing forces act.

The opinion that petroleum is indigenous to the rocks in which it is found has been maintained with great vigor by T. Sterry Hunt and J. P. Lesley, both of whom have based their views upon extended observations in Canada, West Virginia, and Kentucky. At several localities in Canada, Dr. Hunt has observed the marine fossils of the Trenton limestone filled with petroleum in which it was hermetically sealed, and he regards the petroleum that saturates portions

* Abstract of Chapter V. of the Monograph on Petroleum, prepared for the Tenth Census of the United States.

of the Niagara limestone near Chicago as indigenous to that formation. In a recent letter, J. M. Safford informs me that in the limestone rocks that form the Silurian basin of middle Tennessee it is not uncommon to meet with geode cavities lined with calcite crystals and containing more or less petroleum. I am also informed by Edward Orton that the Clinton limestone of Ohio, lying over the whole northern border of the Cincinnati anticlinal, contains petroleum in small quantities. In J. P. Lesley's paper on "the existence of petroleum in the eastern coal field of Kentucky," he has shown that in Johnson County, Kentucky, the great Carboniferous conglomerate is saturated with petroleum at horizons now above the level of the water in the streams that intersect the country. He thinks the coal-measure plants contributed to the formation of the petroleum, and observes that "the specific gravities of the oil, decreasing with the increase of the depth, is a fact which shows conclusively that a chronic evaporation or distillation of the whole mass of oil in the crust of the earth (within reasonable reach of the surface) has always been and is still going on, converting the animal and plant remains into light oils, the light oils into heavy oils, the heavy oils into asphalt or albertite, the process being accompanied at every stage with the liberation of gas." In his introduction to Report III. of the Second Geological Survey of Pennsylvania, he remarks "that it (petroleum) is in some way connected with the vastly abundant accumulations of Paleozoic sea-weeds, the marks of which are so infinitely numerous in the rocks, and with the infinitude of coralloid sea animals, the skeletons of which make up a large part of the limestone formations which lie several thousand feet beneath the Venango oil-sand group, scarcely admits of dispute, but the exact process of its manufacture, of its transfer, and of its storage in the gravel beds is utterly unknown." It is evident that in these later statements Professor Lesley expresses his opinion respecting the changes that convert the original petroleum content of the rocks into the different varieties of petroleum now met with, although in his earlier papers, and particularly in the one first quoted, Lesley has been one of the most conspicuous advocates of the opinion that the petroleum of the Appalachian system is indigenous to the rocks in which it is found. The observations of Wall in Trinidad appear to establish beyond a doubt that the bitumen of that locality has been and is being produced from a peculiar decomposition of woody fiber. Bright and Prestwich both regard the petroleum of England as indigenous in the limestone and shales, and the testimony of E. W. Binney is conclusive as to the production of petroleum from the decomposition of peat on Down Holland moss. J. D. Whitney has suggested that the infusorial remains so abundant in the sedimentary rocks of Southern California are the original source of the petroleum occurring in them.*

I think no doubt can be entertained that in certain localities of limited extent petroleum and other forms of bitumen are indigenous to the rocks in which they occur.

As early as 1804 Humboldt observed a petroleum spring issuing from metamorphic rocks in the bay of Cumana, and expressed the opinion that it was "the effect of distillation at an immense depth." . . . Dr. J. S. Newberry and the late Professor E. B. Andrews have both called attention to the similar character of the distillates obtained from bituminous coals and shales and petroleum, and suggested that petroleum is a product of distillation by natural processes and at low temperatures. Daubrée has in "Études sur le Métamorphisme" very fully discussed the relation of bituminous substances to metamorphism, and has proved by experiment the adequacy of such an origin for all forms of bitumen.

The studies which I have made upon petroleum, extending now over a period of more than twenty years, lead me to the conclusion that as yet very little is known regarding the chemical geology of petroleum. No one has studied the chemical properties of different varieties of petroleum in relation to their geological occurrence in any effective manner; it would therefore be extremely rash for any one to dogmatize with reference to the origin of bitumens. I am, however, led to state the conclusions that a careful survey of our available knowledge of the subject has enabled me to reach. I am convinced that all bitumens have, in their present condition, originally been derived from animal or vegetable remains, but that the manner of their derivation has not been uniform. I should, therefore, exclude all chemical theories as impossible or unnecessary. There remains the hypothesis that bitumen is indigenous in the rocks in which it is found, and that which regards all bitumens as distillates. Whichever of these hypotheses be chosen, the modifying fact must be accepted that there are four kinds of bitumen:

1. Those bitumens that form asphaltum, and do not contain paraffine.
2. Those bitumens that do not form asphaltum, and contain paraffine.
3. Those bitumens that form asphaltum, and contain paraffine.
4. Solid bitumens that were originally solid when cold or at ordinary temperatures.

The first class includes the bitumens of California and Texas. They are doubtless indigenous in the shales from which they issue. It is also probable that some of the bitumens of Asia belong to this class.

I have described the conditions under which bitumens occur on the Pacific coast of southern California in great detail in the reports that I have made to the Geological Survey of that State. The forms of bitumen that are found there are almost infinite in gradation, from fluid petroleum to solid asphaltum. In Ventura County the petroleum is primarily held in strata of shale, from which it issues as petroleum or maltha, according as the shales have been brought into contact with the atmosphere. The asphaltum is produced by further exposure after the bitumen has reached the surface. These shales are interstratified with sandstones of enormous thickness, but I nowhere observed the petroleum saturating them, although it sometimes escaped from crevices in the sandstone, nor was the bitumen held in crevices of large size nor under a high pressure of gas; the disturbed and broken condition of the strata folded at high angles precluding such a possibility.

The topography and stratigraphy of the coast ranges of Santa Barbara, Ventura, and Los Angeles counties are very complex. The Santa Barbara Islands, off the coast bordering these counties, are volcanic islands, where lava-flows are described as having formed cascades over cliffs of sedimentary rocks as they descended into the sea. On the mainland no lava appears to have reached the surface, although along the stage road from San Buena Ventura to Los Angeles, between Las Posas and Simi, on an eroded plateau surrounded by low mountains, fragments of scoria are scattered over the ground. The Coast Ranges here appear to have been produced by parallel folds, each successively higher, by which enormously thick beds of sandstone, interstratified with shale, were thrust up at an angle of about 70°, producing parallel anticlinals, which were subsequently eroded in such a manner as in many instances to produce valleys and plateaus where the sandstones were broken through to the softer shales beneath. This is the case with the western extremity of that fold which, commencing at Point Conception, extends eastward to Mount San Bernardino. West of the Sespe the sandstone crest has been completely removed and the shales cut away until, at the Rincon, east of Santa Barbara, the erosion reaches the sea-level, and beyond, to the westward, the upturned edges of the shale form the bed of the ocean. The narrow plain on which Santa Barbara stands, lying between the Santa Iñez Mountains and the sea, consists of Pliocene and Quaternary sands and gravels resting upon the eroded shales. East of the Rincon and Mount Hoar, the table-lands lying in the trough of the anticlinal gradually ascend until at the Sespé the sandstone caps the high mountain to the eastward. This range, occasionally broken by transverse cañons, extends to near the headwaters of the Santa Clara River near the Solidad Pass, where it becomes merged in the San Rafael range. Between Point Conception and Point Rincon, where a stratum of sand occurs saturated with maltha, that substance has arisen and floated on the sea, attracting the notice of travelers ever since that coast was known to Europeans. At Point Rincon, where the anticlinal recedes from the coast, maltha rises and saturates the Quaternary sands. As the ascending plateau passes farther inland, we find a line of outcrop of the bituminous strata on the east and west sides of the basin in the line of hills east of Mount Hoar and in the Santa Iñez Mountains. East of the San Buena Ventura River, the local synclinal fold in the shale forming the Azufre Mountain gives four lines of bituminous outcrop. In the cañons of the Sespé, wherever the bituminous strata have been reached by erosion, tar springs and asphalt beds are the result. The deeply-eroded narrow valleys which cover the country east of Santa Barbara and south of the Coast Range present in the distance of a few miles the greatest lithological variations, and expose the bituminous strata under the greatest diversity of conditions. For this reason we meet here every possible form of bitumen in every possible degree of admixture with soil and organic remains.

The second class of bitumens includes the petroleums of New York, Pennsylvania, Ohio, and West Virginia. These oils are undoubtedly distillates from vegetable remains, the proof of which seems overwhelming. Pennsylvania petroleum was examined in 1865 by Warren and Storer in this country, and in 1863 by Pelouze and Cahours in France. They found the lighter portion to consist of certain series of hydrocarbons identical with those obtained in the destructive distillation of coal, bituminous shales, and wood when the operation was conducted at low temperatures. Messrs. Warren and Storer also discovered that the same series of hydrocarbons could be obtained by distilling a lime soap prepared from fish oil. The experience of technology has shown that if coals or pyroschists are distilled at the lowest possible temperature, particularly in the presence of steam, a black, tarry distillate is obtained along with a considerable quantity of marsh gas, and very volatile liquids that cannot be condensed except at low temperatures. If these distillates are redistilled, the second distillate may be divided into several different materials, beginning with marsh-gas and ending with very dense oils heavily charged with paraffine. It is impossible to conduct this primary or secondary distillation without producing marsh-gas, but the amount of this gas and the density of the fluid produced will depend on the temperature at which the distillation is carried on and the rapidity of the process. The use of superheated steam is found to increase the quantity of distillate and to prevent overheating and the formation of other hydrocarbons than those belonging to the paraffine series.

The section compiled by Mr. J. F. Carll, for Report III. of the Reports of the Second Geological Survey of Pennsylvania, shows the Devonian shales above the Corniferous limestone and below the Bradford third oil sand 1,600 feet in thickness. This shale outcrops along Lake Erie, between Buffalo, New York, and Cleveland, Ohio, where it is for the most part the surface rock in the neighborhood of Erie and southward to Union City, Pennsylvania. No one can examine this shale without noticing the immense quantity of fucoidal remains that it contains. N. S. Shaler estimates the Devonian black shale of Kentucky to cover 18,000 square miles at an average depth of 100 feet, and to yield on distillation fifteen per cent. of fluid distillate. It is not necessary to follow him in his calculations of the enormous bulk of this distillate as represented in barrels; the important point in this connection is that it is a very persistent formation, being revealed by borings over a very wide area, and doubtless extending eastward beyond the boundaries of Kentucky, beneath the coal measures which contain the petroleum.

If, however, the Devonian black shales are inadequate both on account of extent and position as a source of supply, we may descend still lower in the geological series to the Nashville limestone and other Silurian rocks that underlie that region. Professor Safford writes, in a recent letter, "The Lower Silurian limestone in the basin of middle Tennessee is about 1,000 feet thick. Including the Upper Silurian limestones, the whole thickness of the limestones, in which are found occasionally little pockets or geodes and cavities of petroleum, is not far from 1,200 feet. The most of the petroleum has been found in the upper part (the Nashville) of the Lower Silurian, as, for example, the larger cavities near or on the upper Cumberland River, in the neighborhood of the Kentucky line, both within Kentucky and Tennessee." These limestones underlie the whole petroleum region of southeastern part of Kentucky and middle Tennessee.

The objection urged by Professor Andrews, that the coals in the measures of Ohio and West Virginia, among which these coals occur, have lost nothing of their volatile content, is without force here. Professor Shaler objects that "the condition of the beds that lie below the black shale in the Cincinnati group or in the Niagara section shows that there has been no great invasion of heat since the beds were deposited. Clays which change greatly under a heat of 1,000° Fahr. are apparently exactly as they were left by the sea, and beds retain their marine salts just as when they were deposited. Any great access of temperature in this deposit of the Ohio shale would have been attended by an almost equal rise of temperature in the coal beds which lie within a few hundred feet above; but these coal beds are free from any evidences of distillation or consequences of heat. We have already seen reasons for supposing an erosion of some 3,000 or 4,000 feet of strata from this section; if we could reimpose this section, we should probably bring up the temperature of these rocks by the rise of the isogeothermals or lines of equal temperature about 60°. . . . We are not able to suppose that the accumulation of strata would have elevated the temperature above the boiling point of water. The hypothesis which may be found to account for the formation of this coal oil must take into consideration the impossibility of its generation at another point and its removal to this set of beds, and the impossibility of supposing that it has been in any way the result of high temperatures."

The range of temperature between "the boiling point of water" and "1,000° Fahr.," which is here allowed, is ample for all purposes of explanation.

Mendelejeff objects that "the sandstones impregnated with petroleum have never exhibited the carbonized remains of organisms. In general, petroleum and carbon are never found simultaneously."

These three objections—first, that the supply of organic matter is inadequate; second, that there are no evidences of heat action upon the rocks holding the oil; third, that there are no residues of fixed carbon observed in the rocks holding the oil—are the objections which have appeared to satisfy those who do not accept the hypothesis that regards petroleum as a distillate. I think the first has been already answered; the second and third I shall now examine.

(To be continued.)

* Dr. J. S. Newberry has lately erroneously atributed this theory to myself. Ann. N. Y. Acad. Sci., ii., No. 9.

THE

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